POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

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JOHN EDGAR HOOVER
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Federal Bureau of Investigation
United States Department of Justice
Washington, D. C.

October 31, 1940

Associated Business Papers, Inc.
369 Lexington Avenue
New York, New York

Gentlemen:

In the war-torn world of today America must strengthen her internal and external fortifications if she is to survive the menace of totalitarianism. The protection of our industrial facilities to insure the uninterrupted production of goods and material is essential to our national defense. Based upon this premise the FBI in September of 1939, in accordance with the request of the War and Navy Departments, inaugurated a program to survey the protective facilities of manufacturing establishments having large contracts to provide the government with defense materials. The purpose of the surveys is to submit recommendations to bolster the physical protective facilities of the manufacturing plants for the prevention of sabotage and espionage activities.

The first and final responsibility to give speed and strength to our national defense program by protection against espionage and sabotage lies with industry itself. Only through the energy and alertness of its officials and workers will the full measure of preparedness be attained.

In line with this plant survey program and to assist industrial concerns and municipalities in establishing effective protection against possibilities of acts of espionage and sabotage the FBI prepared a comprehensive booklet entitled "Suggestions for Protection of Industrial Facilities." Because of its confidential nature this booklet is limited in distribution to heads of duly constituted law enforcement agencies and executive officials of industrial concerns manufacturing defense materials under government contracts.

In response to the many questions as to how to obtain this publication I wish to state that a copy will be furnished an industrial concern upon the written request of an executive official.

Sincerely yours,

J. Edgar Hoover

John Edgar Hoover
Director

SABOTAGE AND COUNTER ESPIONAGE

MYSTERIOUS explosions in chemical and explosive plants in widely separated parts of the country are still reverberating in the daily papers and newsreels. These explosions may have been accidental, the result of rapid expansion and new personnel. At the same time the alacrity with which investigations have been started to uncover possible sabotage indicates that the government is alive to the danger of National Defense delays from subversive elements.

Since the fall of 1939, the F.B.I. has been engaged in a survey of protective facilities to assist manufacturers in guarding against sabotage. The program and method of disseminating the resulting recommendations are fully covered in the above reproduction of a letter from J. Edgar Hoover to the A.B.P., the national association of business paper publishers, enlisting aid in reaching in the quickest possible time the executives of all manufacturing plants.

We wish to emphasize that no company, playing a part in the National Defense program, can afford to be without the F.B.I. booklet mentioned. The letter should be brought to the immediate attention of an executive in your company, with particular attention paid to the last two paragraphs. Requests for the booklet should be on company letterhead and signed by an executive official of the company. Inasmuch as the distribution is restricted, we suggest in order to avoid delay that the defense contracts involved be briefly identified in the request letter.

WITH THE EDITORS

◆ **HATCHETS INTERRED . . .** with the election a matter of history and the respective hatchets properly buried the nation gets back to sanity and work. At this writing, only a few days after the election already Democrats are seen openly fraternizing with Republicans and hard feeling is disappearing on all fronts. Like opposing lawyers who walk out of court arm in arm the American people can differ violently when occasion demands but they can also work together for the common good when the welfare of the nation is at stake. This is as it should be. A democracy can not remain divided in thought for any length of time without disastrous consequences; France proved that. If the election proved any one thing more than another it was that the nation is thoroughly united on the question of

◆ **DEFENSE . . .** Defense was no issue in the presidential campaign, both sides were alive to the necessity of a strong defense program, but we are thinking of making an issue out of it. Why? Well, to some extent because of our own mental confusion regarding the program, but primarily to show insofar as is possible, how the defense program is likely to affect the power industry.

The defense program, we understand is speeding up on all fronts, but a large body starts to move slowly and so far it has been difficult for anyone to obtain a concise view of what is taking place. Perhaps we are over ambitious and have bitten off more than we can chew but we are planning to make the January number of POWER PLANT ENGINEERING a Defense Issue. In it we will endeavor to present as complete and concise a description of the defense program as it is possible for us to obtain from available sources at the present time.

◆ **BUTTER TOO? . . .** The war and general economic conditions in Europe have brought forth much discussion about guns and butter or more correctly guns versus butter because over there, it seems, they cannot have both. Well, what about us? Most of us like our butter and the thought of having it curtailed is not a pleasant prospect. Of course, by butter we do not mean butter literally, we mean consumer goods—cars, mink coats, new homes and strawberry shortcake. The question is, can we make the necessary guns and have our butter too? Perhaps. It all depends upon how well, how effectively, we can mobilize and coördinate our resources. Up to the present time we have had millions of unemployed—a decided detriment to our national economy. Now, however, these unemployed may serve us in good stead because many of them can be put to work making consumers' goods while the others are engaged in making guns. The production of everyday useful goods must go on up if we are to preserve our standard of living.

◆ **VERBOTEN . . .** One of the annoying but probably inevitable concomitants of a defense program is the tightening up of restrictions on admission to industrial plants. The necessity for this cannot be denied, yet, unless such restrictive measures are applied intelligently, they may cause unnecessary hardship on those who have legitimate business in such plants. A blind, unreasoning fear of sabotage may easily carry such restrictive efforts to absurd lengths.

In making this plea for a reasonable attitude we are impelled by not entirely unselfish motives. As editors, we find it necessary to have reasonably free access to plants of many varieties and nothing is gained by making restrictions so inflexible as to deny us that access.

If the interchange of ideas and dissemination of knowledge brought about by the technical press is desirable in ordinary times it is even more so in time of an emergency such as this. Practices and processes which are found successful in one plant can be applied with equal success in other plants and the success of the defense policy depends to a large extent upon the ease with which knowledge of such processes are transmitted from one plant to another. Nothing is gained from setting up isolationist policies in this respect. If there are secret processes of military or industrial value legitimate representatives of the technical press can be trusted to keep them.

If given the opportunity the technical press can be of considerable help in coördinating the efforts of industry and it is hoped that its representatives will not be hampered by unnecessary and arbitrary restrictions. Barbed wire fences, no admittance signs, machine gun and tear gas stations are formidable barriers but none of these are half so disheartening as the sweet but firmly intoned voice of the marcelled houri in the main reception room informing you that "no one is permitted in the plant." More than once we have been tempted to wring her lovely neck.

◆ **SERENDIPITY . . .** It's a long way from the subject of national defense to serendipity but the word intrigues us and, come to think of it, may be it does fit into national defense. Until we read about it in the Arthur D. Little Industrial Bulletin, we must admit it meant nothing to us—we never heard of the word and if anybody had accused us of having it, we would have felt put out.

Have you got it? Maybe you have but don't know it; anyway it's a gift, the gift of finding agreeable or valuable things not sought for. A case in point is Columbus' discovery of America. Columbus, as you recall, set out to find the Indies but instead ran smack into a place called America—rather a valuable find if you ask us. Another instance; Dr. Langmuir working in the G. E. Research Laboratory was interested in the behavior of gases in evacuated tubes. He learned a lot about gases but of far greater importance was that, incidently, he found out how to make a better lamp, the Mazda lamp.

◆ **OBJECTIVITY . . .** But it is not merely blind chance that brings these apparently chance discoveries. It is more than a truism that discoveries are made almost exclusively by workers who are keenly searching for an objective. Occasionally the objective may be a bit hazy and at times the searcher finds not what he seeks directly but some thing in its place that may be even more valuable, yet the discovery made is nevertheless an object attained by search.

Much depends upon the background of the individual, on his stock of knowledge, his conscious and subconscious assets. In every person's mind there lie the peculiar items of records of all his former thoughts. They are permanent records. Some of those thoughts may pop out or come to mind unless a novel or unexpected event crosses his mental threshold. This, as Dr. Whitney of the General Electric research laboratory points out, all indicates dependence of the gift of serendipity upon the total (even forgotten) knowledge and training of the individual.

BURNING

Fig. 1. Mountains of wood waste. While wood makes excellent fuel it is bulky and requires large storage space. This is the fuel pile at the Northwestern Electric Co. plant in Portland

THE one thing in the Northwest that is most impressive to the visitor to that region of our country is the great abundance of wood; above all other things perhaps this stands out with startling prominence. From Bellingham near the Canadian border, all the way down Puget Sound to Olympia and down the cost to the Columbia and south into Oregon, wood in all its forms and aspects dominates every scene. From the great firs and hemlocks still growing in the forests to the refuse heaps and sawdust piles outside the mills one is ever conscious of this predominance of wood. Indeed, even its negative aspects are impressive, more properly depressive—the once lovely but now denuded hills along the coast are grim reminders of man's prodigality in the use of this valuable natural resource.

With such an abundance of wood, it is natural that it should find wide use as fuel for both domestic and industrial purposes. In the early days, as was the case in Michigan, Wisconsin and Minnesota when the lumber industry flourished there, the waste from the sawmills was burned in open refuse burners just to dispose of it. Many of these still remain but with growing industrial development and consequent increased competition and greater demand for cheap power, wood waste is also used effectively as fuel to a considerable extent.

While wood, when properly burned, is an excellent fuel, its bulk makes its transportation, except by water, uneconomical. Where the wood waste can be transported on barges to the point of use, it is economical to transport it but where it has to be loaded on trucks or railroad cars, the costs of transportation offset its low cost at the source of supply. Thus at Portland, Oregon, where wood waste can be transported long distances on the Columbia River, the two public service companies, The Northwestern Electric Co. and the Portland Electric Co., both use wood waste as fuel to a considerable extent, whereas they would not find it economical to do so if the plants were not located directly on the river. For these plants, hogged fuel is delivered in barges the largest of which have capacities of around 300 units although these are usually filled to about 350 units. Smaller barges carry 250 units.

A unit of hogged fuel is approximately the equivalent of a cord of wood, depending upon the size of the chips; in volume it is a trifle less than 200 cu. ft. Hogged fuel, generally, has a high moisture content; in Washington and Oregon it runs from 30 to 50 and even 60 per cent moisture. Hemlock usually has a higher moisture content than fir.

With an average moisture content of from 35 to 40 per cent, the heat value of hogged fuel runs approximately 5000 B.t.u. per lb. Bone dry, it runs 8500 to 9000 B.t.u. At the Weyerhauser plant in Everett where wood pulp is produced, the B.t.u. content of bone dry No. 1 fir is 9100. With 35 per cent moisture the heat value runs

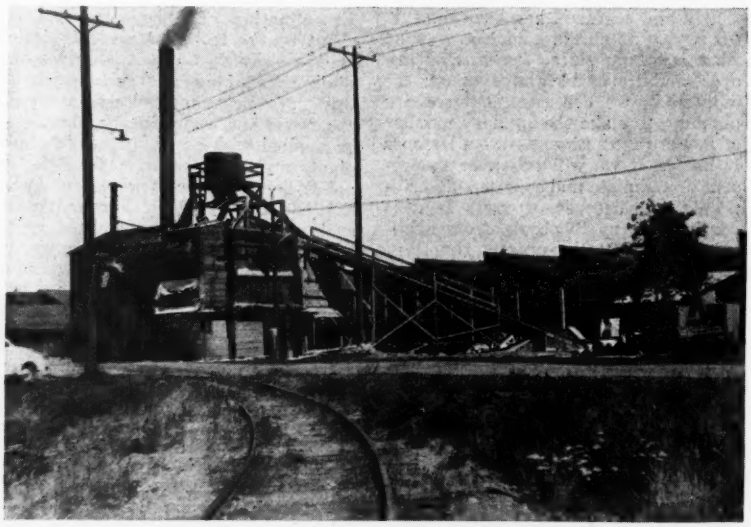


Fig. 2. Not much to look at, still less to write about—the small saw mill plant. There are many of these scattered everywhere. They have a certain amount of "atmosphere" but are of little engineering interest

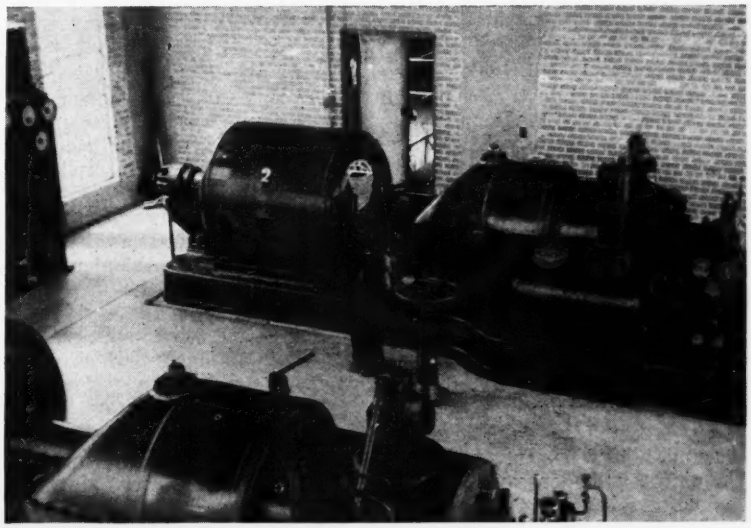
HOGGED FUEL IN THE NORTHWEST

Last summer one of our editors spent several weeks in the Northwest studying various aspects of power development in this region. In this article we present an account of his impressions as they concern the use of hogged fuel in Washington and Oregon. Only the general aspects of hogged fuel burning are covered in this article, however; the more technical details of wood burning will be presented in a subsequent article.

5900 B.t.u. per lb. Hemlock, bone dry, ran 8876 and with 58 per cent moisture content, 3722 B.t.u.

These values of heat and moisture content serve to show why hogged fuel is so bulky and why, even though it is a waste product, its economical use is limited to places close to the point of supply.

Another factor in the use of hogged fuel that imposes a penalty is the necessity for more or less extensive conveyor systems, and large storage facilities. The investment in conveying equipment is very high. Even the shortest conveyor will cost around $5000. The conveyors have to be heavy and ruggedly built because they are required to handle almost anything from sawdust up to large sticks, two by fours, even, and when these jam, the conveyors have to be rugged enough to clear the jams. This question of conveyors is of considerable importance, not only from the standpoint of initial investment, but from the standpoint of maintenance and operating costs. Maintenance costs run high. Unless furnaces are properly designed, refractory maintenance costs also are likely to run high. In one of the most modern plants, the cost of refractory maintenance was ½ cent per unit of wood waste fuel burned.



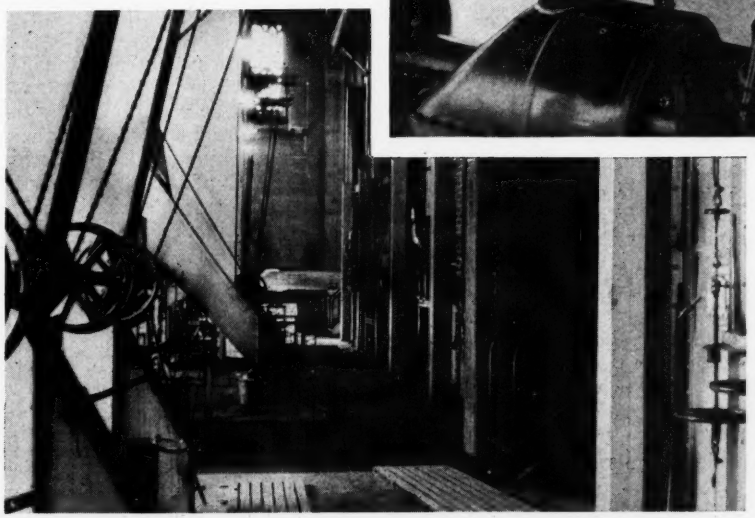


Fig. 3. Left. In the boiler room of one of the large plants. A view looking down on the top of the Dutch oven furnaces. The hogged fuel feeders are shown at the left

Fig. 4. Above. In the turbine room of the U. S. Plywood Corp. at Seattle. A. M. Corliss on watch

Yet, despite these shortcomings, wood waste makes the lumber industry profitable. Many people—lumber people—in the Northwest will tell you that there is no profit in the lumber industry itself, that the profit accrues from the disposal of the waste.

The waste is of two kinds, chips

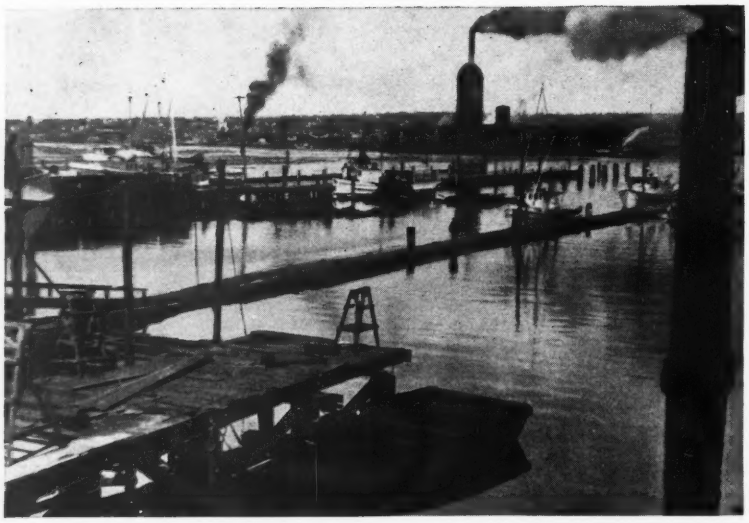


Fig. 5. The Lumber Industry—as far as the eye can see

for pulp wood and fuel refuse. Since the paper industry has picked up, the pulp end of the lumber business has flourished and in some cases the demand for chips for this purpose is so great that entire logs are converted into chips. Logs 3 to 4 ft. in diameter are cut up into chips.

In recent years the manufacture of plywood has increased to a branch of considerable proportions. This dates back about 17 years to about 1923, but it really did not amount to very much until 1930 when it began to gain strength. Around 1932 when everybody felt the pinch of the depression, the demand for this cheap form of wood increased greatly. It provided a much more effective use of lumber resources.

Until that time there was not enough plywood production in the Northwest to create enough waste for fuel and most of the plywood plants purchased their power. As new methods and machines were developed and as the demand for the product grew, production increased to a point where the disposal of waste became a problem; it cost money to have it hauled away.

It was at this stage of development that power generation became feasible. All of the plywood plants had need for a boiler plant for the production of process steam and it was only logical to consider the addition of generating equipment since fuel was at hand.

So power plants were built. One of the first was that at the U. S. Plywood Corp. in Seattle, Washington. In considering the investment that can be made for power equipment in these plants, an important factor is the roving character of the lumber industry. Lumber plants follow the timber and at best a plant can be expected to have a life of from 10 to 15 years and the plywood plant is no exception. Hence, the investment that a plywood plant could make in power generating apparatus was limited to an amount which would enable the plant to pay for itself in a matter of 3 to 5 years.

This requirement rules out new equipment and most of the plywood plants are built largely of second hand equipment. Under such circumstances, in some plants a 500 kw. generator represents an investment of only $5000. Second-hand boilers and second-hand condensers are often used. When built in this manner, a plant is able to pay for itself in a matter of 3 to 5 years.

A typical plant of this kind is that of the U. S. Plywood Corp. in Seattle which has already been mentioned.

This plant consists of 2 Stirling boilers, one rated at 362 hp. and the other at 500 hp. and two condensing turbogenerators. The generators produce three phase current at 480 v.

The 360 hp. boiler was provided to make steam for heating and process work before the electric generating equipment was installed. The 500 hp. unit was added when the generating units were installed. Both boilers operate at 180 lb. pressure.

These boilers are fired with wood refuse from the mill. Since there is a surplus of wood, the question of fuel burning efficiency is relatively unimportant, except as poor efficiency might increase maintenance costs.

In addition to burning the ordinary refuse which runs anywhere between 50 per cent moisture and bone dry, the boilers also burn sander dust. There is a considerable amount of such dust available in this type of plant, the result of taking 1/32 to 1/16 in. off millions of feet of plywood. It contains an appreciable percentage of sand but creates no operating difficulties. Its only effect is to form a loose ash coating on the tubes which flakes off easily.

This sander dust is introduced directly into the combustion chamber. All of the wood burning boilers are provided with Dutch oven type of furnaces in which hogged fuel and other wood refuse is burned. As shown by Fig. 6 the sander dust is fed into the side wall of the combustion chamber, approximately in line with the throat of the Dutch oven furnace. The burner used is one designed for pulverized coal. An exhaust fan draws the dust to the furnace and at the same time blows it into the combustion chamber where it burns in suspension.

Since very high temperatures are attained in the combustion chamber, brickwork maintenance runs high. The plant operates 7 days a week so any repairs to the furnace must be made at times when the plant shuts down for 24 hr. on a Sunday at 3 or 4 month intervals. Even at such times the furnaces do not cool appreciably in 24 hr., so a sectional form of side wall construction is used which permits brickwork to be removed and replaced from the outside. By merely removing the outside steel casing, the old brickwork can be knocked out and new brick laid at once. With this arrangement S. M. Gilbert, the chief engineer at U. S. Plywood, at times has laid brick when the boiler was in operation.

As is usual with most of the wood burning furnaces in the Northwest, the Dutch oven furnace is fitted with water cooled grates. This is general practice but the method in which the water for cooling the grates is used in the system varies considerably in different plants. At U. S. Plywood it is wasted, that is after passing through the grates it is discharged

back into the canal from which it is taken. This particular phase of wood burning will be discussed in greater detail in a subsequent article.

This general description of the U. S. Plywood plant applies to plywood plants in general. In the plants of the big lumber companies, Weyerhauser, Longbell, Simpson Logging Co., etc., a somewhat different picture prevails. In these plants new equipment is the rule and in these plants more modern equipment is used. At the Weyerhauser Pulp Division plant at Everett, for example, 650 lb. pressure boilers are used with a 650 lb. back pressure turbine. These boilers are fitted with instruments, steam flow meters, CO_2 recorders, multiple pointer draft

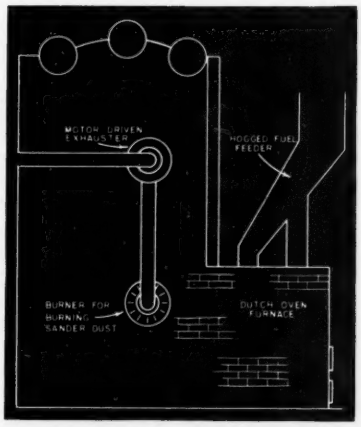


Fig. 6. Sander dust is blown into the combustion chamber at U. S. Plywood

gages, and automatic damper control.

At the Simpson Logging Co. where the first and only 900 lb. pressure boiler in the Northwest is installed, a combustion control system is being considered though at the present time the unit is controlled manually. This combustion control system will control the draft from the steam pressure, as at Weyerhauser. Up to the present time complete combustion control has not been successful with hogged fuel fired boilers, for two reasons: first, because of the varying character of the pieces of wood, and secondly, which is the primary reason, because of the high moisture content of the fuel. The first condition probably could be taken care of by using the differential pressure across the fuel bed as a controlling agent but the second element, the moisture in the fuel, is a much more difficult thing to cope with in devising a combustion control system. The moisture content of the hogged fuel, as already mentioned, varies from a low value to as high as 60, and even 70, per cent and this naturally results in a wide variation of CO_2. C. J. Macke, the manager at the Simpson Logging Co. plant at Shelton, Wash., in discussing this question pointed out that in the operation of their boiler plant the CO_2 which normally runs between 14 and 15 per cent, at times will suddenly drop to zero for no apparent reason—all other conditions appear to be the same. At times he has told the operator not to do anything about it and then the CO_2 will remain low for 20 minutes or a half hour and then again for no apparent reason will climb back to 15 per cent. The reason, of course, is the change in moisture content of the fuel.

At the Simpson Logging Co. plant in addition to the new 900 lb. pressure boiler already mentioned, there are installed six 816 hp., 180 lb. pressure boilers and three condensing turbogenerators. Considerable steam at boiler pressure is needed for process work at this plant, especially in the adjacent pulp mills. Hogged fuel is used in all boilers.

When the need for more power developed, studies were made to determine the most desirable way to meet this requirement. New low pressure boilers and generators could have been added but analysis indicated that a high pressure top was the most feasible solution.

So, a new 100,000 lb. per hr. Babcock and Wilcox integral furnace boiler, built for 900 lb. pressure was purchased together with a 3000 kw. topping turbine, a General Electric machine. This turbine operates at 860 lb., 720 deg. F. and exhausts into the existing low pressure system at 190 lb.

The 900 lb. boiler is equipped for the use of oil as well as wood. The three oil burners with which it is fired are capable of carrying the boiler continuously under a load of 90,000 lb. per hr. Wood is used to the exclusion of oil when it is available.

Plants such as this one at the Simpson Logging Co. and the one of Weyerhauser at Everett mentioned above are not the rule. In the average small sawmill, a different type of plant prevails. At such plants there is usually wood waste in abundance and this engenders a philosophy of operation quite different from that in plants where fuel is scarce and the cost high. Naturally, in plants where wood must be disposed of, sometimes at a loss, efficiency of combustion becomes a factor of relative unimportance. In such plants steam is produced at pressures ranging from 100 to 200 lb. and combustion equipment is limited to a simple Dutch oven furnace, a pressure gage, sometimes a CO_2 recorder. From an engineering standpoint they have little to offer but they are part of a great, if not unified, industry and they have a certain amount of atmosphere.

In another article to appear in a subsequent issue the more technical aspects of wood burning will be considered.

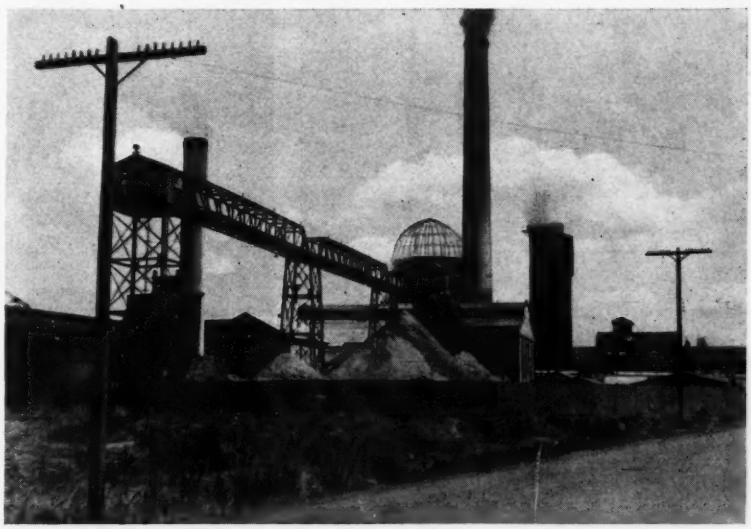


Fig. 7. Conveyors for handling hogged fuel often involve considerable investment

THE INSPECTION OF WOOD

In this, second and final of two articles on the Inspection of Wood, Mr. Rossnagel discusses further defects that should be looked for in the inspection of wood and also how to use wood that is free from these objectionable defects.

By W. ELWOOD ROSSNAGEL
Safety Engineer, Insurance Department
Consolidated Edison Co. of New York, Inc.

IN THE previous article under this title in the October issue the characteristics of spiral grain were discussed briefly and methods for its detection described. Spiral grain can be quite elusive, however.

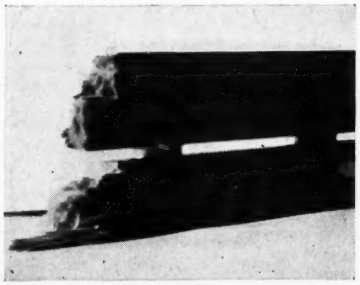
Just to prove how tricky spiral grain is, the model shown in Fig. 1 was made up to represent a large log with a beam cut from it. Examining the beam superficially will give one the impression that it is a good straight-grain timber, and it might be accepted for structural use. A more careful examination will disclose the tiny resin ducts taking a diagonal course on the tangential face, and this is a definite indication of the presence of spiral grain. The proof of this is presented by the spiral course of the checks on the other side of the log. In order to verify this finding a nail was driven into the end of the beam, with the result that a piece was split off on the angle predicted. Such a timber, of course, should not be used for structural purposes. Cross-grain at an angle of 1:15 reduces the strength of a beam by about 25 per cent, and the strength of a column by about 13 per cent.

There is a positive method of testing pieces such as red oak ladder (rungs) for straight grain. If the grain is perfectly straight, the large pores on one end should, if extended, register with the pores on the other end of the piece. If cross grain exists, the pores on one end, if extended, would come out the side of the rung. To make the test one end of the piece is wet with saliva, and the other end is placed in the mouth. Blowing with reasonable pressure will cause bubbles to form on the other end of the piece if the grain is perfectly straight. This test cannot be made on white oak and other woods the pores of which are plugged with tyloses.

Dip Grain is a local deviation from straight grain due to the presence of a pitch pocket or a knot in that piece or in the adjacent piece cut from the same log. Fig. 2 shows a model used to demonstrate this condition. Dip grain is most detrimental when located on the tension side of a beam.

Fig. 1. A section of a log and a beam cut from it to show how tricky spiral grain is

Fig. 2. An example of the defect commonly known as dip grain



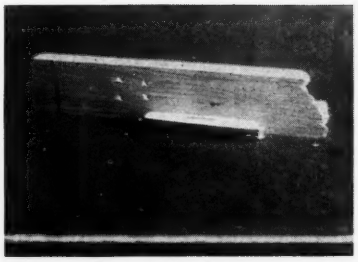


Fig. 3 (above) Fractures of tough and brashy wood
Fig. 4 (below) Test of tough brashy wood

Brashy wood is another defect responsible for many accidents. It may withstand ordinary stresses without failure, but it has very little resistance to impact or shock loads. This condition may be caused by certain factors in the growth of the tree, or it may be the result of long exposure in hot, dry locations such as in the upper portion of a boiler room. Tough wood breaks by progressive splintering and gives a warning before failing; but brashy wood fails without warning, and its fracture has a rather crystalline appearance and extends almost straight across the grain. Figure 3 shows

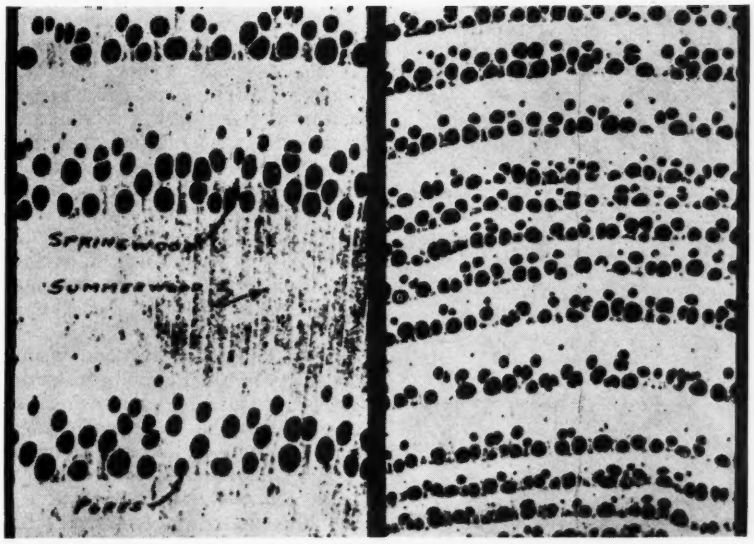


Fig. 5. Magnified sections of hardwood

fractures of tough and brashy wood. It may be asked if it is possible to detect brashy wood before the accident occurs. Any specimen that is exceptionally light weight for its species, any softwood that has abnormally wide annual rings, or any hardwood or softwood that has unusually narrow rings may be expected to be brashy. Brashy wood may also be detected when making the splinter test for cross grain. Instead of a long splinter pulling out, small chips will break off such as from a lump of dry putty. See Fig. 4 for test of tough and brashy wood. There is a peculiarity in the effect of ring width in hard and soft woods. In examining specimens of softwood, it will be noted that the width of the summerwood remains nearly constant in width, the variation being taken by the weaker springwood. Thus, the specimen with narrow rings may have 50 per cent summerwood, while that with wide rings may have only 15 or 20 per cent strong summerwood. The condition in hardwoods is just the reverse (See Fig. 5), the porous springwood remaining almost constant in width. Where the wide ring piece may have 80 per cent summerwood, the slow-grown specimen may have less than 50 per cent strong summerwood.

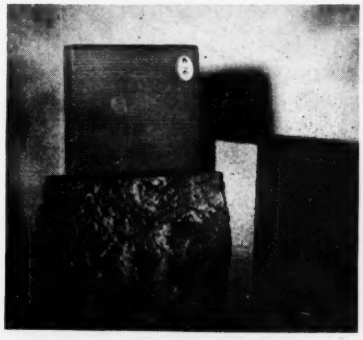


Fig. 6. Compression failures

Perhaps many persons have never heard of a compression failure. This is one of the most treacherous defects, but fortunately it is not very common. Most species of wood have a tensil strength several times greater than the compressive strength. If a long, slender beam is loaded excessively, the fibres on the compression side will begin to buckle, but as they have no place to go to, the piece does not actually fail. If additional load is applied, or if the same load remains for a long period of time, the fibres on the tension side will be pulled apart, and the beam will fail. Now, suppose that instead of increasing the load after the fibres had buckled the beam had been inverted. The compression failure would now be on the tension side where it offers little or no resistance to the beam's bending. Consequently the good half of the cross-section of the beam is called upon to resist the entire bending moment, and, of course, the beam will fail. Such a fracture has an appearance very similar to that of brashy wood. For the reason just mentioned, the author strongly disapproves of the load-testing of ladders, scaffold planks, etc., unless such a test is scientifically conducted by an engineer who is experienced in such work, as there is far greater probability of accidentally producing a compression failure than of detecting one already existing. Detecting compression failures is a job which requires knowledge, skill and plenty of perseverance. Fig. 6 shows compression failures extending across the faces of the pieces and which are indicated by the very faint light colored lines. Such defects are very difficult to detect in newly planed lumber, but impossible to find on rough or darkened wood. Viewing the wood at various angles, and with the light source in different positions may facilitate locating these defects.

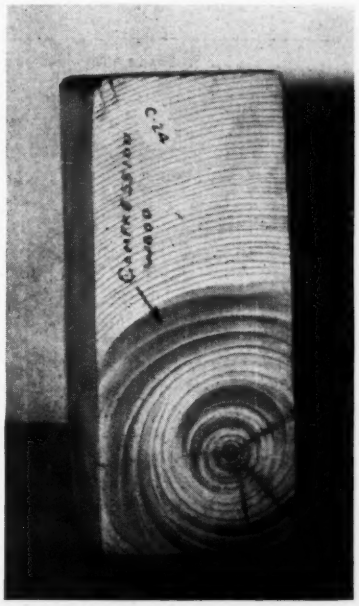


Fig. 7. Compression wood is indicated by wide eccentric rings in certain soft woods

Compression wood is indicated by wide, eccentric rings in certain softwoods (Fig. 7). While very dense, which ordinarily indicates high strength, this wood is brashy and is of low strength. Timbers containing compression wood should not be used for structural purposes.

Next on the list is the defect which all domestic woods develop sooner or later—decay. This is just as much a disease as is smallpox, for instance. Familiar to all are the fruiting bodies which ap-

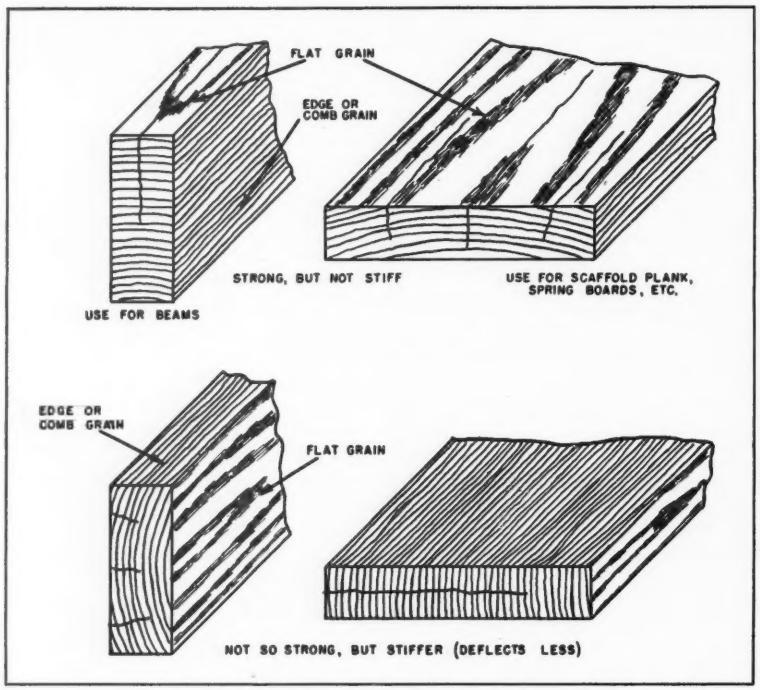

FLAT GRAIN
EDGE OR COMB GRAIN
STRONG, BUT NOT STIFF
USE FOR SCAFFOLD PLANK, SPRING BOARDS, ETC.
USE FOR BEAMS
EDGE OR COMB GRAIN
FLAT GRAIN
NOT SO STRONG, BUT STIFFER (DEFLECTS LESS)

Fig. 8. Beams with rings extending vertically and horizontally

pear on timbers in damp cellars, old sheds, and on tree stumps. These take the form of toad stools, shelves or crusts; and on their under-side are produced millions of germs called spores. These are blown about by the wind, and should they settle on fertile wood, will germinate. In order to be susceptible to decay, wood must be exposed to moisture, but not be continually wet; it must have a certain degree of warmth; and it should have a supply of poorly circulating air. The spores develop on the surface of the wood into white, cottony growth called mycellium, which as it spreads punctures the wood cells and feeds upon their chemical constituents. Decay often progresses on the interior of timbers with little or no evidence on the surface.

There are various symptoms of decay. Rot in the advanced stages needs no elaboration; all are well acquainted with it. In addition to the mycellium, other symptoms of decay are the zigzag zone lines seen on the surface of timbers; continually moist areas especially on the ends of beams; streaks made by extractive liquids oozing from joints in the structure; settling of the structure, etc. Rot in the interior may often be detected by striking the timber with a hammer, drilling small holes and observing the chips, or by jabbing the wood with a sharp knife. Red heart is a form of incipient decay which should not be permitted in structural timbers.

Blue-stain, frequently observed on the surface of certain softwoods, although caused by fungi, is not in itself objectionable. It does indicate, however, that the wood has been exposed to conditions which are favorable to decay.

There are other defects which may be found, such as bark seams or pockets, wane, worm holes and termite attack, but space does not permit them to be discussed at this time.

So much for defects in wood. Consideration will now be given to the proper use of wood which is assumed to be practically free from these objectionable defects. Wood splits more readily radially, or across the rings. Thus, with the rings extending vertically in the cross-section of a beam (Fig. 8), the resistance to horizontal shear will be somewhat less than with rings horizontally, especially if checks should be present. In

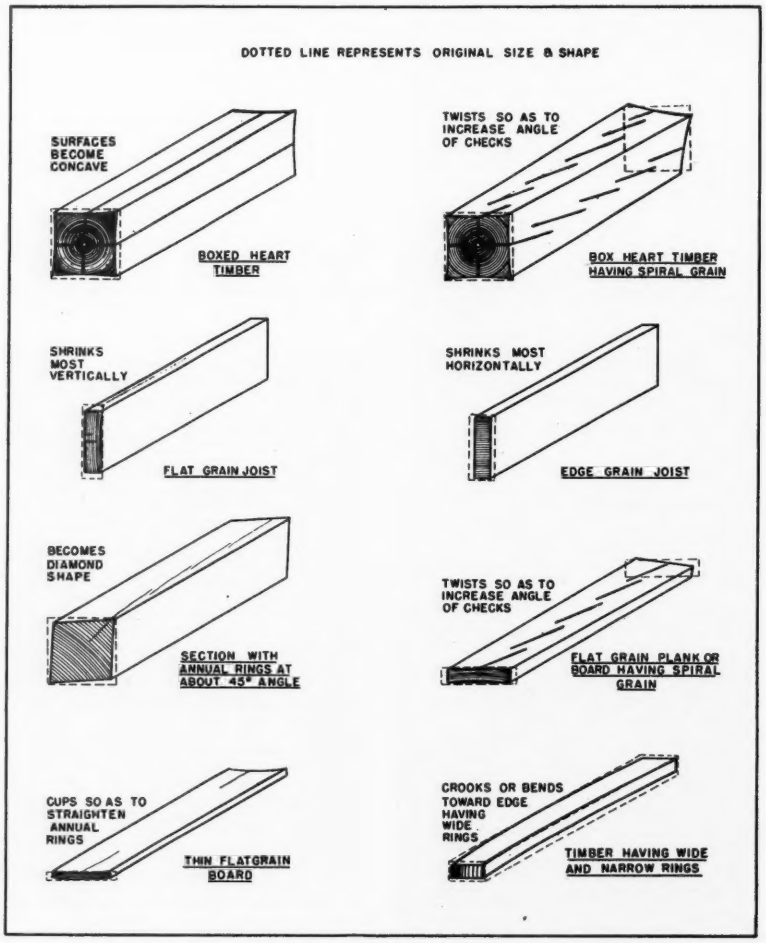

DOTTED LINE REPRESENTS ORIGINAL SIZE & SHAPE
SURFACES BECOME CONCAVE
BOXED HEART TIMBER
TWISTS SO AS TO INCREASE ANGLE OF CHECKS
BOX HEART TIMBER HAVING SPIRAL GRAIN
SHRINKS MOST VERTICALLY
FLAT GRAIN JOIST
SHRINKS MOST HORIZONTALLY
EDGE GRAIN JOIST
BECOMES DIAMOND SHAPE
SECTION WITH ANNUAL RINGS AT ABOUT 45° ANGLE
TWISTS SO AS TO INCREASE ANGLE OF CHECKS
FLAT GRAIN PLANK OR BOARD HAVING SPIRAL GRAIN
CUPS SO AS TO STRAIGHTEN ANNUAL RINGS
THIN FLATGRAIN BOARD
CROOKS OR BENDS TOWARD EDGE HAVING WIDE RINGS
TIMBER HAVING WIDE AND NARROW RINGS

Fig. 9. Warping of wood due to drying (somewhat exaggerated)

general, if the rings extend vertically the beams will be somewhat stiffer. If they run horizontally the beam will be slightly stronger, but will deflect more. If they extend diagonally, the beam will be both of reduced strength and stiffness.

On the other hand, for columns and poles boxed heart timbers (those containing the pith at the center of the cross-section) should be used. Wood beams differ from steel beams in that the strength of wood is reduced after long periods of loading. In other words, a beam will sustain a much greater load for a few days than it will over a period of years. If the load is applied for only a few seconds, or as in the case of tool handles for only a fraction of a second, the unit stress withstood may be several times as great.

In drying, wood warps in certain definite ways, unless influenced by outside factors. As shown in Fig. 9, wood always shrinks more in a direction parallel to the annual rings, the dotted lines indicating the shape of the piece when green. Boards or timbers, containing spiral grain in drying warp so as to increase the angle of twist, and flat-grain boards cup in such a manner as to cause the annual rings as seen on the end of the pieces to straighten somewhat. Wood containing groups of wide and narrow rings will usually crook or bow so as to be concave on the side having the wide rings.

There are many other factors involved in the inspection of wood which cannot be dealt with in a treatise of this kind. Wood is not a synthetic material like steel for instance, the properties of which can be kept under definite control, but being a product of nature is variable in quality. Two pieces of wood not only of the same species but even from different parts of the same tree will have somewhat different characteristics. Notwithstanding this fact, and strange as it may seem, the more one studies wood and learns of its defects, etc., the more faith he will have in the safety of a structure constructed of wood.

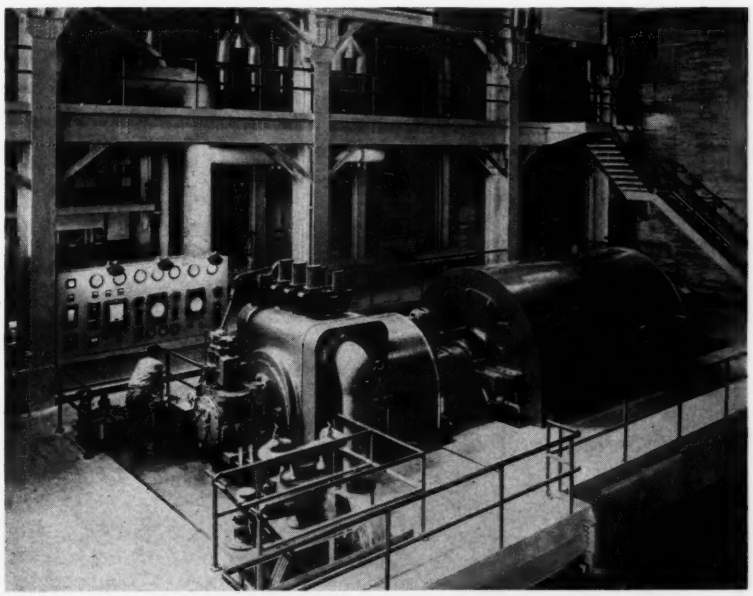
By recognizing the various defects in a timber and by analyzing the effect they will have on its strength, it is possible to estimate within reasonable limits the load which it may be expected to safely carry.

New Generator Design Isolates Double Frequency Vibration

DOUBLE-FREQUENCY vibration, heretofore a special problem in two-pole turbine-generators, has been practically eliminated by General Electric in a spring-mounted, 3600 r.p.m. generator recently installed in the Westport station of the Consolidated Gas, Electric Light and Power Co. of Baltimore. The new generator, installed in July, is the first of its type to be put into operation. The spring-mounted design of the 25,000-kw. turbine-generator isolates vibration so well that it is impossible for a man standing alongside the generator to tell, either by sound or by touch, when excitation is applied or removed.

Such an amazing reduction is accomplished by the use of a flexible mounting for the stator structure. Isolating the vibration at its source and confining it to the laminated core, this resilient core mounting does away with the annoying 120-cycle "transformer hum" which has always been characteristic of large high-speed generators under excitation. Also transmission of the double-frequency 7200-per-minute disturbances to the foundation and nearby structure is prevented.

While simple in construction, the resilient core mounting involves a great many considerations in design. Heretofore, the laminated core has been stacked on long dovetail "key-bars," or "ribs," which have been attached directly to the frame. In the new construction, the same "key-bars" are employed but are attached to twin sets of spring-bars which in turn are joined to the frame in such a way as to provide flexibility between the "key-bars" and the frame. Vibrations are thus absorbed by a flexibly mounted core, resilient enough to prevent them from being transmitted to the frame.



This 25,000-kw. unit at Westport Station has a spring mounting

COMBINED STOKER-PULVERIZER FIRING

Addition of unit pulverizers to underfeed stoker fired boilers, increased capacity and efficiency, cut maintenance and reduced stack discharge

By CARL G. HERSHEY

UPON TAKING CHARGE of a steam electric station, the writer found that a serious operating problem was the difficulty in burning the coal available for the underfeed stokers used with the six boilers, each of which had a normal rated capacity of 70,000 lb. of steam per hr. This coal was ½ in. to dust screenings, averaging 4 per cent moisture and having very pronounced caking tendencies. Other properties were as follows:

Ash, % dry basis.....16.6
Volatile, % dry basis.....24.5
Fixed carbon, % dry basis...58.9
B.t.u. per lb., A & M free...15,473
Ash softening pt., deg. F....2950

This fuel had the characteristic of igniting and burning very slowly, and when a boiler was being fired above about 70 per cent normal rating, the incoming coal did not attain its maximum intensity of combustion until it had reached the vicinity of the ash-pit. Consequently this location was the hottest part of the furnace. As the softening point of the ash was about the same value as these ash-pit temperatures, clinkers would build up so rapidly on the back wall that they had to be barred off each shift in order to avoid complete bridging over of the ash-pit.

In addition, the load on a boiler had to be dropped every 24 hr. to permit more effective cleaning of the back wall, and also to remove accretions from the side walls of the ash-pit. Under such conditions of operation, the boiler efficiency was low, the cost of back wall and stoker maintenance was excessive, and the firm steaming capacity of the boilers was so much below normal rating that the station output was seriously limited.

Screen tests showed that about 30 per cent of the coal used would pass thru a $\frac{1}{16}$ in. mesh, and it was thought that if a large portion of these fines were eliminated, the more porous fuel bed obtained would permit an increased flow of air from the wind box, and might result in improved combustion. Arrangements were therefore made to secure a number of cars of this same coal in the form of $\frac{5}{8}$ to ⅛-in. screenings for trial.

Sized Coal No Help

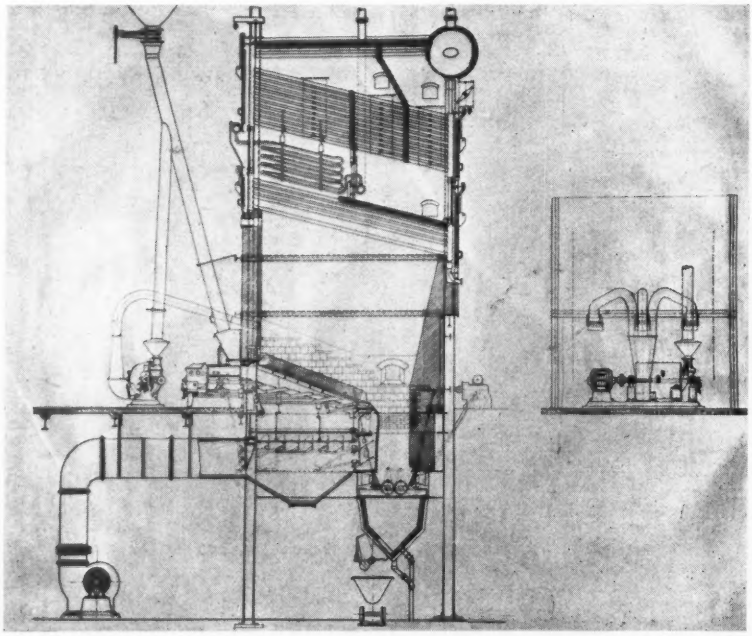
With this latter coal, it was found that while it was possible to carry a more uniform fuel bed and there was less building up on the back wall but the rate of combustion was slower, the ash-pit losses were greater and the boiler capacity was much reduced. Similar tests were made with a washed coal from the same mine which ran from 2 down to ½ in. in size, but the results were even less favorable. By such tests it was established that a given weight of ½ in. to dust screenings would produce more steam than was possible with any of the other coal sizes tried out, and also that a greater boiler capacity could be obtained.

It was concluded that the reason for this was on account of the finer coal having much more surface area for a given quantity than did any of the other sizes, and that this factor permitted a more rapid rate of combustion.

As it was obvious that the basis of the trouble was the slow burning qualities of the coal and as fuel from no other district was available, much thought was given to devising means to improve the combustion obtained with the fuel at hand. One idea was to lengthen the stokers and so provide a longer period for the coal to burn before reaching the ash-pit, but construction difficulties made this scheme impractical. Discarding the stokers entirely and changing over to pulverized coal was considered, but as this plan would require a very material increase in furnace volume, it was feared that the changes necessary would make the cost prohibitive.

Pulverizer Added

It was finally decided to equip one boiler with burners for pulverized coal and operate them in conjunction with the stoker, on



Six of these boilers were installed in 1930. A pulverizer was added to one unit in 1936 and after 6 mo. trial the remaining five were provided with pulverizers

the theory that the temperature at the front of the furnace would be increased and that this would speed up the ignition and burning of the coal on the stoker. Accordingly a unit pulverizer was installed on the firing floor in front of the boiler, and coal was piped to it from the same overhead bunker feeding the stoker.

Three simple burners were installed in a row across the front of the boiler and at a short distance above the fuel bed on the stoker, with the burner angle such that the lower end of the flame would just clear it. The unit pulverizer was of a size such that it could carry about one-third of the normal boiler rating. The location and arrangement of the pulverized coal equipment in relation to the boiler is shown on the drawing, which shows a side and also a front elevation of the installation.

Upon trying out this combination method of firing, the results obtained were gratifying. Checks were made using an optical pyrometer with and without the pulverizer, and in both cases with the boiler operating at the same rating, showed representative temperatures to be as follows:

Furnace front wall
without pulverizer ...2000 deg.
with pulverizer .....2600 deg.
Furnace back wall
without pulverizer ...3000 deg.
with pulverizer .....2625 deg.

The increased temperature at the front of the furnace caused the incoming coal on the stoker to ignite rapidly and to be practically burned out by the time it reached the ashpit. Tests made from composite samples of ash obtained over a period of several days showed the combustible loss in the ash to be less than 1.5 per cent with the boiler operating continuously at normal rating, and this, of course, gave a large increase in boiler efficiency.

Building up of clinkers on the back wall was reduced to a small fraction of the former rate, and the periods of cleaning were extended to 30 da. intervals in place of the former practice of every 8 hr. With stoker firing it was the custom to completely shut down, clean and overhaul a boiler every 10 wk., but this stoker-pulverizer fired boiler was on the line for 33 wk. before it was arbitrarily shut down for inspection and overhauling, after having produced normal rated steam flow for practically the entire period.

This plant was located in a cotton producing area and it was feared that the adoption of stoker-pulverizer firing for all the boilers might increase the amount of fly ash discharged, with possible repercussions from the cotton growers. Accordingly, steps were taken to determine the relative amount of solids passing out of a stack with both methods of firing. Normally, more than one boiler discharged into a stack, but for these tests it was arranged so that the pulverized equipped boiler could have a stack by itself.

To make these tests a 2 in. pipe was inserted through the stack wall about 30 ft. above where the gases entered from the boiler, and was extended to a point near the stack center. The other end of the pipe was brought down to the ground level and connected to the suction side of a small exhaust fan which discharged into a double woolen bag.

Fly Ash

Firing with the stoker alone, the boiler was operated to produce steam at a constant rate, and for a period of 1 hr. gases were drawn from the stack by the exhaust fan and the fly ash filtered out in the bag. Following this the solids collected were weighed and then the test was repeated with the same volume of steam being produced by stoker-pulverizer firing.

A sufficient number of these tests were made to avoid any possibility of error, and the results showed that with the same boiler output, about 8 per cent more solids were passing out of the stack with stoker firing than was the case with the combination method.

Screen tests made on the collected ash samples showed that about 85 per cent of the solids discharged to atmosphere using stoker-pulverizer firing would pass through a 100 mesh screen, and that this was a much greater percentage than was the case when the same load was being carried by the stoker alone. As the stacks were 328 ft. high, these finer particles would be distributed over a very large area, and as the total amount of ash going to atmosphere was less with the pulverizer, it was obvious that the cotton growers would have less cause for complaint.

After a trial period of 6 mo., it was decided to equip the remaining boilers with unit pulverizers, and after this was done it was possible to make accurate checks to determine the extent of the improvements obtained. It was found that: the boiler efficiency was at least 12 per cent higher than it had been; the firm steaming capacity had been increased by better than 20 per cent, and the cost of boiler maintenance was about half of what it had been previously. As the coal consumption at this plant was often in excess of 10,000 t. per mo., this improved method of firing made a very material reduction in operating costs, and the installation of the pulverizers was paid for in a comparatively short time.

National Defense Increases Reading

NATIONAL DEFENSE has brought to America's libraries many new and critical problems. Requests for vocational, industrial and technical books and pamphlets top the list of calls that have literally overwhelmed librarians since the national defense program was launched, the Library Service Division, U. S. Office of Education indicated.

The nation's summertime army of more than 100,000 defense trainees in vocational schools of about 500 cities has taxed the reading and study resources of libraries. Both enrollees and instructors look to libraries for books and up-to-the-minute information useful in defense training courses.

Technical Books in Demand

Libraries find technical departments crowded with those preparing for jobs, those wanting to learn how they can secure jobs, and others studying or reading something suggested by national defense needs.

Not uncommon today are requests reaching librarians from students, engineers, industrialists, and others for literature on machine tools, machine design, manganese, aerodynamics, naval architecture, ship-building, airplane manufacture and assembly. There is considerable interest at present in military regulations, facts on explosives, air raid protection, and first aid.

Patrons in many instances have indicated that their requests "are due to a desire to serve the Government in the national defense program."

Growth of World Water Power Development

By H. E. M. KENSIT

NO COMPREHENSIVE and reliable particulars of world wide water power development appear to be available before 1920, when they were first compiled and published by the United States Geological Survey for 109 countries. However, data for the 10 leading countries are available as far back as 1914 or nearly 25 years ago and were collected by the writer from official sources as soon as practicable after that date. These figures appear fairly reliable for the following reason. The last great war, the "World War", largely or wholly cut off the fuel supply to several European countries and caused them to give intensive attention to development of water power in order to meet their vital needs for war purposes. This led those that did not already possess government water power bureaus to form them in order to deal adequately with the matter, and most of these countries included in their first official reports after the war a statement to the effect that: "In 1914 our total water power installation only amounted to so many horsepower, but it has now increased to so much", which formed a definite starting point. The ten leading countries for which these particulars are available and which are listed in Table I accounted in 1920 for nearly 95 per cent of the world total of turbine horsepower installed and in 1939 for nearly 90 per cent, so they may be taken to adequately represent world progress in water power development. The international statistical authority SOFINA and the World Power Conference estimate the world electric power production on that of a closely similar list of countries.

Table I. World Growth of Water Power Development by Leading Countries

	Horsepower Installed		Increase 1914 to 1938		
	1914	1938(1)	Mean Annual % (2)	Number of Times	In Order of Growth
Canada	1,951,000	8,191,000	6.2	4.2	8
France	800,000	5,400,000	8.3	6.7	2
Germany	900,000	4,000,000	6.4	4.4	7
Italy	1,000,000	6,000,000	7.8	6.0	3
Japan	590,000	4,800,000	9.1	8.1	1
Norway	530,000	3,000,000	7.5	5.7	4
Spain	281,000	1,400,000	7.0	5.0	6
Sweden	850,000	2,200,000	4.1	2.6	9
Switzerland	500,000	2,800,000	7.5	5.6	5
United States	8,609,000	17,949,000	3.1	2.1	10
Total for 10 countries	16,011,000	55,740,000	5.5	3.5	

(1) Last year for which data is available.
(2) The rate that compounded annually gives the final figure.

As to the influence of war on water power development, while as aforesaid some European countries speeded up that work during the last war, this did not greatly affect the total increase; the mean annual rate of growth from 1914 to 1920 for the ten countries listed in Table I was about 5.2 per cent, but for the whole period from 1914 to 1938 it was 5.5 per cent.

Commenting on Table I, the mean annual percentage increase is the only correct way to show the growth over a period of years. To take, as is so often done, the percentage increase over the whole period and divide that by the number of years to get the average, is wholly misleading; for instance, in the first item on the list, the average so obtained would be over 13.3 per cent which would give a total for 1938 far in excess of the actual.

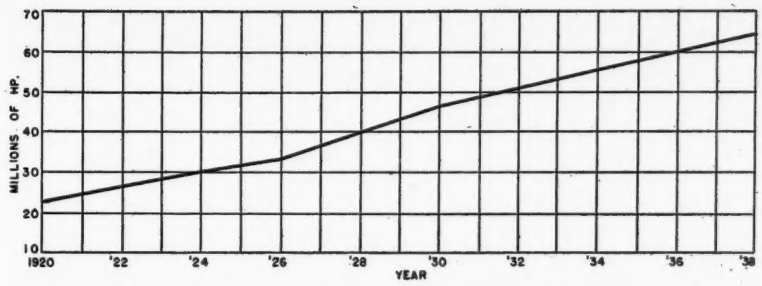
Commenting on the above Table II, it may be remarked that while North America shows least rate of increase of any continent, that is because it already possessed in 1920 the highest degree of development, this being over 53 per cent of the world total, and in 1938 it still stood at 48 per cent; the amounts for the United States and Canada separately are shown in Table I. In respect to Europe it will be seen that, contrary to the general impression, the total development is greater than that of North America. As to Asia, 4,800,000 or nearly 80 per cent of the total is in Japan. The percentage for Africa is misleading, for while that country has water power resources of 274,000,000 hp., or over 40 per cent of the world total, her entire development is only equivalent to one moderate sized plant.

The diagram of the growth of water power development from 1920 to 1938 is of interest as showing the remarkably uniform rate of progress. When this is taken over the world as a whole it evens up. Thus in the period from 1930 to 1934, which includes the worst of the great depression, while that in the United States increased less than 12 per cent, that in Europe increased over 32 per cent.

The question what proportion of the water power resources of each country and of the world are now utilized is a contentious subject and in the writer's opinion is usually much underestimated. The official estimates of resources are so far as possible "all-in" estimates, but there must be a large

Table II. World Growth of Water Power Development by Continents

	Turbine H. P. Installed		Increase	
	1920	1938	Of H. P.	Number of Times
North America	12,210,000	27,000,000	14,790,000	2.1
South America	424,000	1,400,000	976,000	3.3
Europe	8,877,000	28,000,000	19,123,000	3.2
Asia	1,160,000	6,100,000	4,940,000	5.2
Africa	11,000	183,000	172,000	16.6
Oceanica	147,000	800,000	653,000	5.4
World	22,829,000	63,483,000	40,654,000	2.8



Growth of Developed Water Power of the World (installed turbine horsepower)

proportion that, on account of inaccessibility or physical disadvantages and of the great advance in late years in the efficiency of fuel power, are not now financially desirable. For example, in 1928 the Chairman of the Water Power Development Committee of the now extinct but very capable National Electric Light Association made a detailed study of this matter and reached the conclusion that over 53 per cent of the officially estimated water power resources of the United States were: "probably not now economically feasible", over 53 per cent.

In the light of events since 1928 that reasoning would now doubtless put the proportion not practicable at a still higher figure. But this is for a country that is highly developed in this respect and that has utilized the pick of her available water power resources.

Let us endeavor to make up an estimate. This may well be based on the data compiled by the United States Geological Survey since 1920. The writer has followed these since their inception, compared them with all the principal compilations by the recognized bodies in other countries, and believes the Survey's figures to be the most complete and reliable anywhere available. A huge item of which the future cannot be foreseen is Africa. As above shown, with 274,000,000 hp. of water power resources she has only added some 170,000 to her installed horsepower in the last 18 years, and for any future that can now be visualized she can be left out of the calculations. Then an estimate may be made, as in Table III.

So that deducting Africa and making what may be called a conservative estimate, there is still but a small percentage of the available water power resources of the more populated countries so far utilized.

Table III. Utilization of World's Water Power Resources

	Horsepower
World water power resources at minimum flow and 100% efficiency	671,000,000
Less for Africa	274,000,000
	397,000,000
Reduce for 80 instead of 100% efficiency	318,000,000
Say 70% practicable	223,000,000
Equivalent installation. Say 2½ times the minimum flow	558,000,000
Amount installed 1938, excluding Africa	63,256,000
Per cent of resources now utilized	11.3

Schools and the Nation*

UNUSUAL, uncertain and precarious conditions now face the American people and their institutions. Our country now faces the greatest challenge in its history, for never before did so many strong nations envy our wealth and wish our downfall.

It is quite apparent that many of our people have not yet awakened to the seriousness of the national situation, which is our situation. They will undoubtedly realize it eventually, and the danger is that it will then be too late. The throes of war have already gripped three continents, and if we are to keep this terrible struggle from our shores there is certainly no time to lose. One should not be classed as an alarmist if he calls attention to the facts of the situation and warns against delay in providing adequately for national defense. Any institution or any individual who can contribute toward making the national defense impregnable, and who wastes time and opportunity to do so, may be considered a traitor to our country.

Unquestionably, the supreme national duty now is to engage swiftly in the upbuilding of our navy, the strengthening of our army, the transforming of our industry into the manufacture of airplanes, tanks, and munitions, the mobilization and training of our manpower. To waste time in doing this is inexcusable and it will bring tragic consequences. Yet, preparedness calls for discipline of a more general type as well as that of military training.

Our immediate concern is to arouse the personnel of this institution to be collectively and individually prepared to meet such emergencies as may arise and such eventualities as may occur. Should neither such come to pass, the individual will be the better equipped to meet the usual duties of life, and the institution may have learned through experience some practical ways of making its efforts more effective in educating for the needs of life in a rapidly changing world.

The particular purpose is to encourage the faculty and the other personnel of the institution to respond readily to whatever demands may be made upon them for the services of alert and effective personalities. This seems to require a dynamic and a direct procedure in the education of the intellect, the body, and the emotions, as a coordinated whole, and the shaping of this education to meet the exigency occasioned by the present unprecedented war upon humanity, and the resulting disruption of the world order.

*From an address to the general faculty of Virginia Polytechnic Institute by Dr. Julian A. Burruss, president of the college.

Power Plant Operating Problems

In connection with this article on the Fort Collins, Colo., municipal plant, our attention has been called to an error in the list of equipment on page 66 of the November issue. The feedwater regulators should have been credited to the Northern Equipment Co. These are Copes Type RG-2, two on the B&W boilers, shipped in 1935 and one for the Erie City unit shipped this year.

PAINTING WITH A GARDEN HOSE

Method of painting adopted by the company for painting transformers applicable to a wide variety of industrial work. Stripping off old paint as important as applying new and the author tells all the secrets.

By P. R. Watson

Substation Div.
Union Elec. Co. of Mo.
St. Louis, Mo.

TO REPLACE the expertly wielded paint brush with a spurting stream of paint from a garden hose seems like a lazy man's way of doing things, but the Electric Power Plants Department of Union Electric Co. has thereby solved the problem of painting power transformers. Painting with a directed stream of paint, or Flo-coating,* is a relatively recent addition to the bag of tricks used to maintain power transformers and was first tried by our Company at the Cahokia Power Plant in 1937.

There are two major reasons why this has replaced the usual method of painting. First, and most important, it assures an unbroken paint film on the transformer radiators. Second, it cuts the job time approximately in half. This is important because the requirements for service are usually such that the transformers may be taken off the load only at selected times and for short periods.

In a few cases in the past, painting has been neglected because the usual methods would require more time than the transformers could be spared. Flo-coating has enabled us to repaint some transformers without removing them from service.

Painting a power transformer is a fairly simple job—in places. The top and the base are easy. Either a brush or a spray gun can be used. The difficult places are the radiators. On a power transformer, these tubes are so close together that a paint brush cannot reach in to touch the far sides, and a spray gun, even with a specially designed head, will not give a uniform coating. The spray loses its force and becomes a floating fog when directed into the maze of tubes. A thin coat which looks like a paint film may result, but it is only a "color," and will not protect.

An idea of the care taken to assure an unbroken film may be obtained from the practice of one utility to use a dental mirror to examine the rear surface of the tubes. During the painting operation one man was kept busy with the mirror looking for spots which the brush or spray gun had missed.

Some companies, in their efforts to get a perfect coat of paint, have gone to the extreme of removing the radiators and dipping them in a vat of paint. This is obviously an aggravating and costly procedure.

The paint mixture used in flowing is quite interesting. The mixture is very thin, and although its total drying time is about equal to ordinary paint, it does not take its initial set quickly. When poured on the transformer, it all runs off except a smooth, unbroken film next to the metal. The excess which runs off is caught and re-used. The thickness of the mixture can be controlled by the painter, and must not vary, because too-thick paint will not run off properly, causing "curtains" and "drips," and too-thin paint will run off too freely and leave bare spots or an insufficient coating.

Special Paint Required

The equipment needed is simple. A motor-driven pump, of 10 to 20 g.p.m. capacity, is required to raise the paint to the painting head at the top of the transformer. The painting head consists of the nozzle, which is made of ¾ in. pipe about 6 in. long, slightly flattened at the tip, and the handle, which is ¾ in. pipe about 3 ft. long, connected to the nozzle by a 45 deg. elbow. The pump and painting head are connected by garden hose long enough to allow the nozzle to be carried to the extreme top of the transformer.

Pans for collecting the paint as it drains off are arranged around the base of the transformer. It is essential that the pans be easily handled, because each make of transformer, and each size, requires a different arrangement to catch all the paint.

An essential part of the flo-painters' equipment is a hydrom-

Fig. 1. Painting the radiators of a large transformer from a scaffold 8 ft. above the ground

*This term used by the author is a trade name coined by James B. Sipe & Co., Pittsburgh, Pa., to designate a method of painting developed by them and especially adapted to field and maintenance work. The equipment needed consists of a pump and motor, necessary hose and pipe connections, catch pans, and specially prepared paint which will flow out (it may be brushed or sprayed if desired) and drain without leaving bags and curtains.

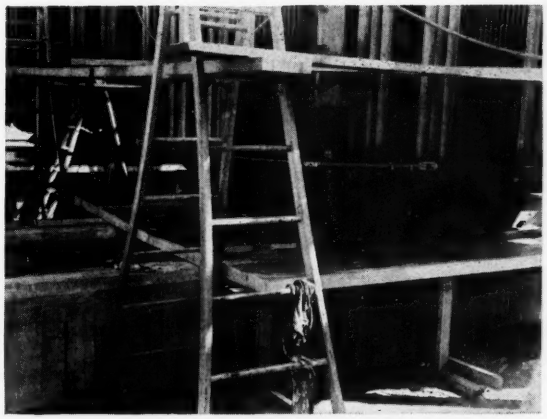


Fig. 2. Collecting pans around the base of the transformer. Paint which drains off flows through the hole in the center pan and is used again

eter, which is used to measure the gravity, or thickness, of the liquid paint. The one used is of the same type as used for testing anti-freeze in automobile radiators.

As previously mentioned, the secret of Flo-painting lies in properly controlling the thickness of the paint. As received, the paint is very thick, and the hydrometer float rides high in the liquid. As thinner is added, the float sinks. When the specified gravity, as recommended by the paint manufacturer is reached, the paint is of the proper consistency for flowing. Frequent checks are made during the painting to be certain that the thickness has not changed.

Actual flowing operation needs little explanation. The painter stands on the scaffold and begins at some convenient point. An assistant adjusts the flow of paint with a by-pass valve on the pump. The nozzle is used to direct the paint at all surfaces, and into crevices and between the tubes of the radiators. The flowing is supplemented by spraying and hand-brushing for painting the tops and trucks. It is not necessary to flow these less complicated parts.

Tricks in Paint Removing

An equally interesting adjunct to paint flowing is paint stripping. In many instances the condition of the old painted surface is such that all existing paint must be removed before repainting can be satisfactorily accomplished. An outfit has been developed to perform this task by flushing on a strong, hot caustic solution which takes off all the existing paint and leaves a clean steel surface for painting.

Essential parts of the outfit are a large heating kettle, two pumps, and a spray head. In use, the paint-removing solution is heated almost to boiling in the kettle, and pumped up to the spray head. The head is directed to wet a considerable area of paint, and this area is then allowed to soak for a few minutes.

When the paint has softened, the spray is brought back to wash it off. After all paint is removed, the whole surface is flushed with clear water to rinse off what remains of the caustic. Handling the paint remover is similar to handling the paint, because the same pans are used for collecting the caustic as are used for the paint, and the remover is also recirculated.

One of the pumps is used to return the caustic from the pans to the heating kettle, where it is re-heating, and the other pump is used to elevate it from the kettle up to the spray head. The paint remover used is prepared commercially, especially for this sort of work.

In some cases, paint removing has been as much of a problem as painting. The "hot-stripper," described above, promises to be as great an improvement over the old methods of removing as flo-coating is over the old methods of painting. A previous method of paint-stripping used caustic in cold solution, but it was not recirculated. It was also necessary to use starch in the mixture, so that the solution would stick to the paint. While it worked satisfactorily, it required 2 to 3 da. to strip one large transformer. The hot-stripper will do the job in one day or less.

Several experimental set-ups for hot stripping have been made, and the experience gained has led the Substation Division to assemble a special outfit. The heating kettle is of the type ordinarily used for heating roofing tar, but has a larger burner. The kettle holds 165 gal. of liquid. Ordinary centrifugal water pumps are used to handle the hot solution.

DRY AIR

Often in laboratory or process work, it is desirable or necessary to have a supply of dry air. When the quantities involved are sufficiently great to warrant the installation of refrigerating or drying equipment, this presents no particularly difficult engineering problem. When, however, the quantities are small and the service more or less temporary, the problem of meeting the requirement without undue expense is sometimes difficult.

A practical solution of the drying problem worked out by the aviation industry in connection with aircraft ignition harness is simple and can be applied to other applications. This was described recently by Carl E. Swanson before a meeting of the S. A. E.

Activated alumina is the drying agent used. Activated alumina has the property of absorbing moisture at substantially 100 per cent efficiency until it has taken up between 12 and 14 per cent of its dry weight. Beyond this point it continues to absorb, but at decreasing efficiencies, until saturated, at which time it contains 20 to 25 per cent adsorbed water.

This material is commercially available in a color indicator grade and is indigo in color when fully reactivated. During the adsorption of moisture the material changes progressively through pink to white, and therefore provides an indication of its degree of saturation when used in a transparent container. Reactivation is accomplished by heating the desiccant within the temperature range 350 to 600 deg. F.

Flow rates of approximately 10 to 20 cu. ft. per hr. per lb. of activated alumina are suitable for complete drying of air. Higher flow rates can be employed when complete drying is not required. When a choice of air intake is possible, it is desirable to locate the intake in a region of low temperature rather than high temperature for the reason that cold air will in general have a lower absolute humidity.

RELATION OF CHIMNEY TO SMOKE ABATEMENT PROBLEM

With natural draft the chimney performs the same service as fans with forced draft and should be sized with the same care, not on the basis of arbitrary boiler horsepower, but on the basis of the maximum gas flow

By J. G. MINGLE

CHIMNEYS in connection with any plant, industrial or domestic, serves a two-fold purpose. First, to create a draft for the feeding of air to the installation and second to dispose the products of combustion at such a height that they will not become a general nuisance. The performance of chimneys parallels in a general way that of centrifugal fans and centrifugal pumps.

Draft, or pulling-power, of a chimney is greatest when there is no gas flow. As the gases start flowing, the draft decreases as the volume increases until the volume becomes so great that the draft is practically negligible. Somewhere between these two extremes lies a region where the chimney will operate in accordance with the demands imposed upon it, provided the size has been properly selected.

Almost since the time chimneys were first built, it has been the general custom to select the size from an arbitrarily computed table of chimney sizes based only on boiler horsepowers, or their equivalent. This is equivalent to selecting the size on the basis of the amount of gases to be handled with no respect being paid to the draft requirements of the plant. Ordinarily, no further attempt was made to check this selected size to determine whether the height was sufficient to create the draft necessary to overcome all of the various draft losses throughout the installation, or whether the area was sufficient to enable the chimney to dispose of the gases quickly and efficiently.

Why It Smokes

As a result, the great majority of the chimneys in operation today are either too short in height, too small in diameter, or what is far worse, badly proportioned. In view of this slipshod and haphazard method of getting at the proper size of a chimney, it is no wonder that these structures are called "smokestacks". They are "smoke" stacks in the true sense of the word.

Of all the parts of a plant contributing to the production of smoke, the chimney is the worst offender. What makes a chimney smoke is a typical and embarrassing question frequently asked. The answer lies in the fact that reasonably perfect combustion is not obtained due to the fact that the height and area of the chimney was not properly selected (computed) to provide sufficient draft demanded by the installation for the amount of gases passed on to it.

In other words, a chimney smokes because its size is not sufficient to supply the proper draft to enable a particle of air to come into intimate contact with a particle of fuel, and also because the gases are not quickly removed from the furnace. For a chimney to function perfectly, it must be capable of supplying the required draft intensity at all rates of combustion so that the proper amount of air may be supplied to the fuel, and at the same time, it must promptly remove the gases from the furnace and properly dispose of them.

Proper sizing of a chimney to an installation introduces problems much too involved to be discussed in detail here. Suffice it to say that, for any one set of operating conditions, there are as many possible and proper sizes as there are values of chimney gas velocity to be assumed.

The problem of the computation of this size may be attacked from the standpoint of first cost by determining an economical chimney gas velocity which will result in a size whose cost will be least, or by determining a velocity which will result in a size which will operate most efficiently. Common sense usually prompts one to determine a required size whose first cost will be least. The accompanying table of chimney sizes based on the draft and capacity requirements has been computed from the standpoint of least cost. Chimneys selected from this table will operate in accordance with the demands imposed upon them.

Use Maximum Gas Flow

It is no more possible to arrive at the proper, and most economical size of a chimney without a thorough investigation of the operating conditions under which it is to perform than it is to select a proper fan, or a centrifugal pump, without a thorough knowledge of the operating conditions under which they are

Weight of gases, lb. per second	Chimney diam., ft.	Required draft, in. of water	Chimney gas temperature, deg. fahr.						
			350	400	500	600	800	1000	1500
			Required height of chimney, ft.						
5	2.8	.45	113	102	86	77	65	60	52
10	3.7	.50	125	113	95	85	73	66	57
15	4.3	.55	138	124	105	94	80	73	63
20	4.9	.60	150	136	114	102	87	79	69
25	5.3	.65	163	147	124	111	94	86	74
30	5.7	.70	175	158	133	119	102	93	80
35	6.1	.75	188	170	143	128	109	99	86
40	6.4	.80	200	181	152	136	116	106	91
50	7.0	.85	213	192	162	145	123	112	97
60	7.6	.90	225	203	171	153	131	119	103
70	8.0	.95	238	215	181	162	138	126	108
80	8.5	1.00	250	226	190	170	145	132	114
90	8.9	1.05	263	237	200	179	152	139	120
100	9.3	1.10	275	249	209	187	160	145	125
110	9.6	1.15	288	260	218	196	167	152	131
120	10.0	1.20	300	271	228	204	174	158	137
130	10.3	1.25	313	282	237	212	181	165	143
140	10.6	1.30	325	294	247	221	188	172	148
150	10.9	1.35	338	305	256	230	196	178	154
160	11.2	1.40	350	316	266	238	203	185	160
170	11.5	1.45	363	328	275	246	210	192	166
180	11.8	1.50	375	340	285	255	218	198	171
190	12.0	1.55	388	351	294	264	225	205	177
200	12.2	1.60	400	362	304	272	232	212	183
225	12.8	1.65	...	373	313	281	239	218	188
250	13.4	1.70	...	384	322	289	246	224	194
275	13.9	1.75	...	396	332	298	254	231	200
300	14.4	1.80	...	...	342	306	261	238	205
325	14.7	1.85	...	...	351	315	268	244	211
350	15.3	1.90	...	...	360	323	276	251	216
375	15.8	1.95	...	...	370	332	283	258	222
400	16.2	2.00	...	...	380	340	290	264	228

Table I. Mingle's recommendation for economical sizes of natural draft chimneys. Based on sea level atmoshperic pressure, a mean air temperature of 62 deg. F. and a mean coefficient of friction of 0.016 for sooted surfaces. Variations of gas temperature has little effect on chimney diameter. For practical purposes select the size to the nearest 0.5 ft. diam. and height to the nearest 5 ft.

to perform. Just as it is necessary to determine the total dynamic head and the required capacity of an hydraulic installation before it is possible to select a centrifugal pump, for example, so it is necessary to determine the total dynamic draft and the required capacity of a steam plant installation before it is possible to determine the chimney size.

Total dynamic draft includes the draft loss through the furnace and fuel bed, the draft loss through the boiler, the draft loss through the accessories such as the superheater, the economizer, etc., the draft loss through the breeching, the draft loss due to turns and bends, the draft loss due to sudden enlargement and contraction and the draft loss due to velocity, all measured in inches of water gage column. The capacity for which the chimney should be designed is the maximum amount of gases generated in the furnace and passed on to the chimney.

A properly designed, and operating, chimney will create the necessary draft, termed available draft, whose intensity will be at least equal to the total dynamic draft requirements of the installation outside of the chimney itself, and at the same time discharge the maximum amount of gases generated by the furnace.

Since there are about 100,000 chimneys in operation in this country, the size of which in most cases has been selected from tables based only on boiler horsepowers, the question arises as to what can be done with those whose height, or diameter, are insufficient for the operating conditions imposed upon them. The usual custom where the situation has become desperate is to extend the height, if structurally possible, it being impossible to alter the area.

When More Draft Is Needed

Extending the height of an existing chimney increases the draft-capacity performance to a small extent which may be sufficient to make up for the original deficiency, or for increased loads after the structure has been built. The only other method to alter the draft-capacity performance is to increase the chimney-gas temperature, a very inefficient way to accomplish the end to say the least. Both procedures are similar to providing an impeller with a larger diameter in a centrifugal pump and at best are only a makeshift.

The best method is to provide a centrifugal forced-draft fan, or a centrifugal induced-draft fan, to operate in conjunction with the chimney and supply the deficiency in both draft and capacity which the chimney lacks. After a complete analysis has been made of the draft and capacity requirements of the plant, and also the draft and capacity capabilities of the chimney itself, a proper size fan can then be selected which will over come the deficiency in both draft and capacity.

It is utter folly, as well as a useless waste of money, to allow a chimney to smoke. Smoke represents an economic waste of fuel. The carbon particles carried away in smoke should have been burned in the furnace. Only by providing sufficient draft by the chimney, and with the assistance of a fan operating in conjunction with it, when the plant is being operated at its maximum rate can smoke be eliminated entirely.

Some municipalities have attacked the smoke problem from the standpoint of ordinances compelling the use of prepared fuels. Others provide for intervals throughout the day when the chimney is allowed to belch smoke of a limited degree. Still others allow smoke of a limited degree throughout the entire day. It is doubtful whether smoke abatement of any worth while degree can ever be effected by legislation. Smoke, like morals, is not subject to legislation. Both are primarily questions of education.

OXYGEN PEPS UP DIESEL

Investigation of the effects of increasing the oxygen concentration on the operating and starting characteristics of a Diesel was made by E. R. Klinge at Pennsylvania State College in connection with his thesis for a master's degree. A report of the investigation was made by Prof. P. H. Schweitzer to the A.S.M.E. A 3¼ by 4½ in. C.F.R. Diesel engine with a compression ratio of 15.8 to 1 and a speed of 890 r.p.m. was used in these tests.

BY INCREASING the oxygen concentration from the normal 21 to 45 per cent, the indicated horsepower of the test engine increased from 4.3 to 6, the brake horsepower from 2.9 to 4.65. The maximum cylinder pressure rose from 700 to 780 psi, but the maximum rate of pressure rise, which is an index of the shock loading of the engine, decreased from 88 to 60 psi per deg. The ignition lag which was also shortened from 9½ to 5 deg.

Specific fuel consumption increased from 0.43 to 0.59 lb. per i.hp.-hr. or from 0.64 to 0.76 lb. per b.hp.-hr., and the exhaust temperature increased from 620 to 1000 deg. F. under optimum timing conditions and with clear exhaust. The explanation for the favorable showing of the oxygen boost with regard to cylinder pressures and rates of pressure rise is obviously the extremely beneficial effect the oxygen has on the ignition lag which was about cut in half by the oxygen addition.

With 55 per cent oxygen concentration the power figures further increased somewhat, but at above 50 per cent oxygen occasional detonation was experienced. The comparison was made at optimum injection timing, and the injection advance angles varied between 10 and 12½ deg., depending on the oxygen concentration.

Using the absolute maximum load the engine is able to carry is impracticable as under such load the engine soots up quickly. Instead of that, the comparison was based

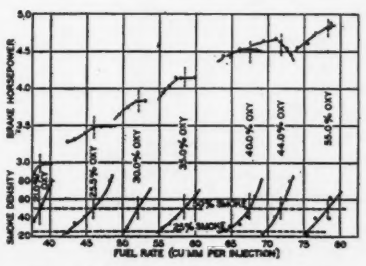


Fig. 1. Test results for optimum timing conditions

on "50 per cent smoke" as registered on the Penn State smokemeter. This incidentally is the approximate limit of "clear exhaust." When the smokemeter registers 50 per cent the exhaust smoke just begins to become visible to the naked eye against a blue-sky background. By simultaneously measuring power output and smoke, Fig. 1 was obtained. Typical oscillograms under normal and boosted operation show that the oxygen boost does not make the indicator card higher or steeper, only fatter.

Oxygen Helps Starting

To determine whether oxygen is a good starting aid a series of reference fuels, from 29 to 72 cetane number, were tested with various degrees of oxygen boost, by determining their critical compression ratios which caused them to ignite within a period of six injections after switching on the injection. The final results are shown in Fig. 2.

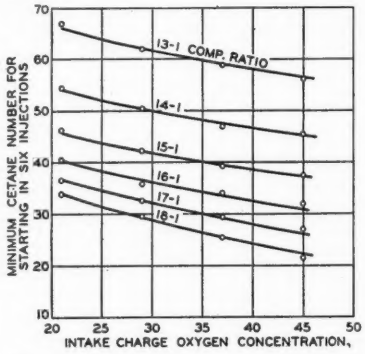


Fig. 2. The effect of oxygen on the starting of engines. The concentration is in per cent oxygen by volume

It is evident that by raising the oxygen concentration from the normal 21 per cent to 45 per cent the minimum cetane number may be lowered by roughly 10 units; in other words, the oxygen boost is equivalent to raising the ignition quality of the fuel by 10 cetane numbers. The oxygen addition, however, was much more potent in improving the ignition of the fuel in the running engine. By the Penn State R.C.R. method an oxygen boost from 21 to only 26 per cent was sufficient to raise the apparent cetane number by 10.

Smoke Reduction

Five per cent increase in the oxygen concentration was sufficient to make a black exhaust invisible. At high oxygen feed, at a rate of 50 per cent concentration or higher, occasional "detonation" was observed. To the ear it was a high-pitch "pink" but lasted for only one or two revolutions at a time. Its occurrence was unpredictable. It was accompanied by an irregular pressure rise and considerable smoke. Below 45 per cent oxygen concentration no detonation was observed.

IS OILLESS OPERATION AN IDLE DREAM?

In some services internal lubrication of reciprocating machines such as compressors, steam engines, internal combustion engines and vacuum pumps, is difficult or undesirable and this article summarizes part of the experimental work that has been done in the development of lubricationless machines

By Max F. A. Wulfinghoff

INTERNAL LUBRICATION, or lubrication of all those parts which come into contact with the medium flowing through the machine, is usually considered to be an indispensable item in the setup of reciprocating machinery. Where the operating temperature is low and the medium chemically inert, as in ordinary air compressors, this offers no particular difficulty, and it becomes especially simple when water or glycerine can be used instead of oils, as in certain types of refrigerating compressors.

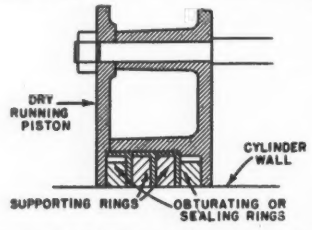


Fig. 1. Detail of an oilless piston design which made possible pulling a 97 per cent vacuum as compared with 94 per cent with a conventional design

With engines running on saturated or moderately superheated steam, proper lubrication of cylinders[1] and valve gear, especially with conservative piston speeds, can easily be maintained. With higher superheat, however, the lubricating system becomes more and more intricate, and eventually the behavior of the lubricant turns out to be one of the limiting factors. Above 800 deg. F., oil will partly evaporate, and its hydrocarbon constituents may even decompose to form solid deposits which increase wear.

Perfect cylinder lubrication in reciprocating engines operating within those ranges of temperature and speed considered as normal today is difficult to obtain, and very probably a certain amount of metallic contact will always be present. Furthermore, it is usually necessary to remove all traces of oil in the exhaust steam. This may be done either by: mechanical means, as baffles or centrifugal separators; chemic-

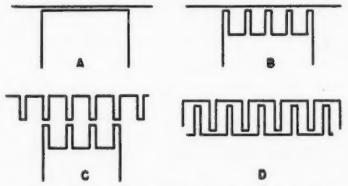


Fig. 2. Four types of sealing members. A, a smooth cylinder wall and piston. D, a perfect labyrinth seal applicable to turbines and centrifugal pumps but not to reciprocating machines. B and C, modification of the labyrinth seal for use with reciprocating machines

[1]See Eliminating Engine Cylinder Lubrication, Power Plant Engineering, July 15, 1930, p. 825.

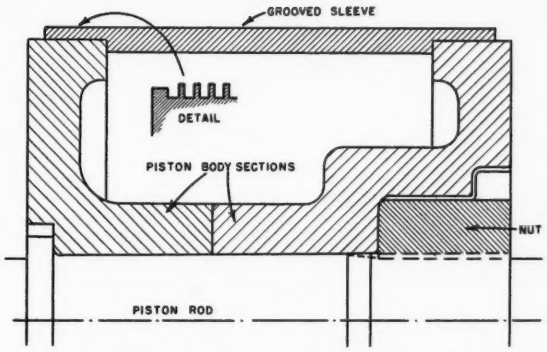


Fig. 3. Another piston design making use of the type B (Fig. 2) seal

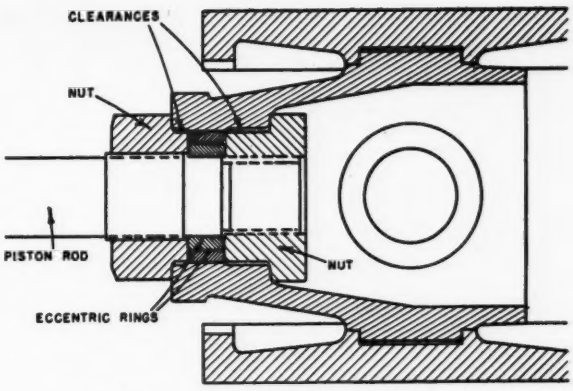


Fig. 4. Special crosshead design to permit centering of piston rod

al methods, such as coagulation and subsequent filtering; or, by physiochemical processes, such as adsorption by activated coal, etc. However, the efficiency of oil separators of any type remains somewhat questionable, unless constant attention is given to them.

As far as the internal combustion engine is concerned, eliminating cylinder lubrication would mean a further step ahead in the design of a commercially successful Diesel engine running on either solid, pulverized, or colloidal fuels.

Absence of entrained oil in compressed air and other gases is essential in ventilating, spray-painting, civil engineering work, and in the pneumatic transport of liquids.[2] In chemical industry, a contamination of gases and gas mixtures with oil may be dangerous. Oxygen, for instance, may cause explosions in the presence of oil. In breweries and in many food industries, even traces of lubricants are likely to spoil the taste or the odor of a product. To efficiently clean air or gases from oil, it may be necessary to lower their temperature in a special cooler so that the oil vapors condense and can be caught by one of the methods mentioned before.

In certain processes, external work can be gained by replacing a high pressure expansion valve with an engine, as in the manufacturing of synthetic hydrocarbons, and in gas liquefaction. In the latter case, oil in the cylinder limits the lowest possible operating temperature.

Under all these circumstances, doing away with internal lubrication in reciprocating units opens interesting prospects. Methods for achieving a satisfactory solution of this problem are, first, the use of piston rings requiring no oiling, such as rings made of a special composition of plastics or carbon;[3] second, elimination of contact between moving and stationary parts.[2]

Obviously, the former solution has its uses mainly for compressors and vacuum pumps, particularly for those of the slow running kind. In tests with suitably designed pistons, the tightness was even found to be superior to that of the usual lubricated construction; for the new design made possible 97 per cent vacuum against 94 per cent in the old design.

Figure 1 shows the details of construction. The piston is made of a lightweight alloy, built up of several parts and does not touch the cylinder wall. The rings, made of a special material, support the piston and tighten at the circumference. They are held in intermediary rings secured by cast iron clamp collars.

The inner surface of the cast iron cylinder is highly polished. Annular condensing chambers prevent internal corrosion. The smoothness of the cylinder and piston surfaces and that of the stuffing box packing rings increased with the running time. The valves on the machine were of the automatic disk type, spring loaded.

Analogous designs, using carbon instead of composition piston rings, have also been proposed and tried with steam engines. In this connection, it must, of course, be kept in mind that the running conditions of carbon piston rings are much less favorable than those encountered in the case of turbine glands.

It is readily seen that, especially with high piston speeds, the second solution offers better possibilities, provided the materials employed are sufficiently resistant against erosion, and that the coefficient of thermal expansion for the moving parts corresponds to that of the stationary parts. Since there is no heat conduction through contacting parts, the temperatures of piston and cylinder wall may differ to some extent. Furthermore, corrosion must be prevented, and the materials involved should lend themselves to being machined to a sufficient degree of accuracy.

In selecting a suitable design, choice must be made in the same way as for ordinary machinery, between expensive high-class construction offering a very high degree of tightness, and less expensive types with a larger allowable margin in efficiency. Also, the unit size exerts some influence. As the piston diameter increases, the useful surface goes up as the square of the diameter, while the length of the circular clearance only increases in linear proportion. This would indicate an advantage of the larger size, but on the other hand, smaller cylinders are easier to machine to exact fit.

Regarding the most efficient section of the obturating members (stopping or sealing parts, the

[2]See Oil Free Compressed Air, Power Plant Engineering, July, 1938, p. 467.

[3]Machines of this type for high pressure process use have been in operation for some time and will be described in an early issue.

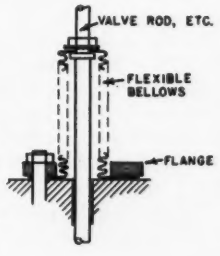


Fig. 5. Flexible bellows used as a seal for small valve stems

piston on the one hand, cylinder wall on the other), different shapes have been investigated. Typical contours are given in Fig. 2, and Fig. 3 shows an example of a piston featuring small cut teeth, and intended to run in a smooth cylinder. The narrow clearance (0.004-0.02 in.) must be carefully maintained, which calls for adjustable piston rods and other refinements.

Naturally, clearance margins are easier to maintain in vertical type engines than in horizontal ones where gravity tends to deflect the piston rod. If a horizontal design must be used, the piston rod may be made curved so as to counteract the influence of its own weight and that of the piston. Figure 4 shows a crosshead designed to permit adjustment of the rod center. If necessary, the expansion of the cylinder wall can be controlled by jacketing the latter and maintaining an appropriate temperature.

The design of the power piston and of the cylinder walls, however, represents only a part of the problem. If the medium passing through the engine is to remain uncontaminated, the distributing valve parts and stuffing boxes must also be kept oil-free. This may be achieved by following the same basic principles as are used in the case of the power piston. With extreme steam conditions, the high pressure stuffing box can be eliminated by employing two single-acting high pressure cylinders instead of one double-acting one. Valve rods of small size engines may be fitted with a flexible bellows as in Fig. 5.

In any case, lubricating oil adhering to the crank drive and valve gear linkage must be prevented from entering the cylinder and valve chest. Automatic flap valves in compressors, and poppet valves in steam engines, need no lubrication.

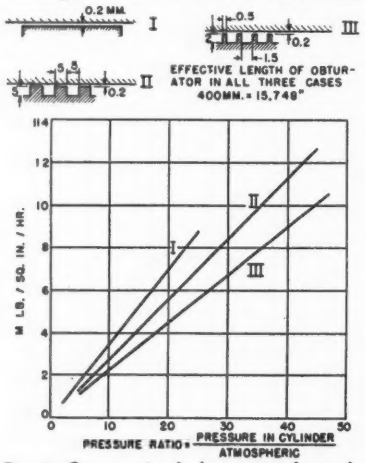


Fig. 6. Comparative leakage rates for seals (Types A, B and C of Fig. 2) with air as the test medium

In recent years a number of investigators have conducted experiments to serve as a basis for calculating the leakage that may be expected with different types of clearance contours.[4]

Referring again to Fig. 2, A is an arrangement comprising a smooth cylinder wall (casing) and a smooth piston (obturator). D shows for comparison a perfect labyrinth as used in turbine glands which naturally cannot be employed in the case of reciprocators. However, B and C represent intermediary solutions applicable in the case of a reciprocating rectilinear motion, the former featuring a smooth casing and grooved obturator, while the latter comprises a grooved casing and grooved obturator.

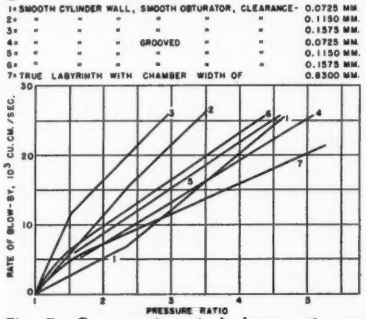

1= SMOOTH CYLINDER WALL, SMOOTH OBTURATOR, CLEARANCE- 0.0725 MM.
2= " " " " " " 0.1150 MM.
3= " " " " " " 0.1575 MM.
4= " " GROOVED " " 0.0725 MM.
5= " " " " " " 0.1150 MM.
6= " " " " " " 0.1575 MM.
7= TRUE LABYRINTH WITH CHAMBER WIDTH OF 0.6300 MM.
RATE OF BLOW-BY, 10^3 CU. CM. / SEC.
PRESSURE RATIO

Fig. 7. Comparative air leakage ratios as influenced by pressure and clearance

With A, leakage depends primarily on the radial clearance and effective length of the obturator and increases as the third power of the clearance in the laminar range or if turbulent flow prevails, as the 1.5 power of the radial clearance. This type is superior to B and C up to a given value of the Reynolds number. With the higher Re values encountered in actual engine design, better results obtain with B and C, which increases turbulence much more than A, and therefore offers more commercial possibilities.

In a perfect labyrinth, D, the flow energy of the medium involved, would be entirely dissipated by turbulence; the theoretical expression for the flow does not take into account the effective length of the obturator, nor does it consider the radial clearance of the diameter. The area of clearance determines, however, the degree of tightness.

For B and C, experiments show that the leakage depends on the width and depth of grooves, distance between throttling edges, and shape of edges. The depth of the grooves has considerably less influence than has the groove width.

The optimum groove width depends on the radial clearance. In the vicinity of the optimum point, slight variations in groove width hardly influence the rate of leakage. Furthermore, the groove width may be assumed as independent of the ratio between the actual operating pressure and atmospheric. Consequently, any B or C design superior to type A with a small pressure ratio, will also prove more satisfactory with larger ratios.

For the B and C arrangements, no exact data regarding the increase of leakage with dimensions seem to be available in the laminar range but in the turbulent region the influence of the radial clearance is generally lower than in A type. For larger groove widths, the rate of leakage approximately corresponds to the free section.

Influence of an eventual eccentric position of the piston in its cylinder on the rate of leakage or blow-by is definitely smaller in the case of B and C than it is with the A design. Ratios found experimentally by different workers, for the rate of leakage in the case of eccentricity as compared to the concentric situation are:

For Type A,
with laminar flow.....about 2.5
with turbulent flow..... 1.21
For Type B and C,
with laminar flow..... 2.1
with turbulent flow (groove width exceeding 0.02 in.) below 1.2

With wide grooves, the influence of eccentricity disappears. Figures 6 and 7 give comparative rates of leakage for types A, B and C, based on a unit section, and show the increase of leakage with larger ratios of pressure.[5]

In actual construction, losses of the working medium will to some extent be offset by savings in lubricants, reduction of friction losses and elimination of equipment otherwise necessary for lubricant recovery or elimination. This indicates the economic limit for an application of "oilless" designs of the second kind.

[4]See Flow Through Labyrinth Glands, by Dr. C. Keller, Power Plant Engineering, April, 1937, p. 243.

[5]Data for Fig. 6 and 7 taken from experiments reported in a thesis by K. Trutnovsky, Polytechnic of Graz, 1936.

REFRIGERATING BRINES*

The nature of the brine used in refrigerating systems is of less importance than the quantity of air that comes in contact with it in the course of operation.

By D. W. HAERING
President D. W. Haering & Co., Inc.

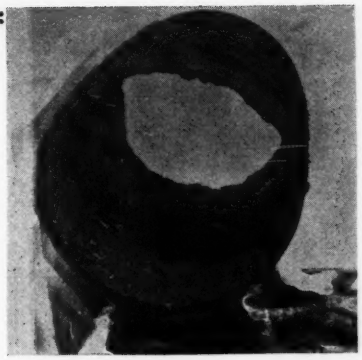


Fig. 1. Corroded Brine Pipe

REFRIGERATING BRINES representing high concentrations of chloride ions are particularly corrosive solutions and especially so when allowed to come in frequent contact with air. This question of the consequences of brine contact with air is not generally understood. While much has been written regarding the relative corrosion characteristics of salt, calcium and calcium magnesium brines, little has been said about the effect upon the corrosion characteristics of a brine in contact with air. As a matter of fact, the nature of the brine is of far less importance than the quantity of air contact occurring in operation.

From the standpoint of scale deposit, there is less probability of trouble in the use of salt brine but in low temperature systems there is no choice and the refrigerating engineer is generally confronted with the problem of using whatever brine is employed in his plant with little choice of material.

The widespread use of sodium dichromate for brine treating warrants comment on this material. Regardless whether dichromate or chromic acid is employed in the brine system, the end product after pH adjustment is sodium chromate which does the inhibiting. Dichromate generally costs less than chromic acid for treatment and there is no apparent advantage to use of the acid. The high chromium contents carried using the inorganic chromates are a distinct disadvantage to this method of treating and the organic chrom glucosates which are more effective and introduce far less chromium into the brine are enjoying increasing popularity for brine corrosion control.

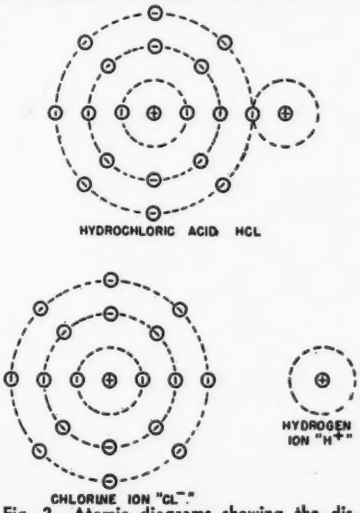


Fig. 2. Atomic diagrams showing the dissociation of hydrochloric acid

Regardless of the nature of brine corrosion control treatment, pH adjustment is a necessary part of brine correction. High pH values encourage scale formation and destroy galvanizing while low pH values greatly accelerate corrosive tendencies. Routine adjustment of pH values is an important phase of brine control.

Ammonia leakage in brine systems will cause excessively high pH values which should be promptly neutralized by acids introduced under supervision of a chemist. In some cases, ammonia may not prove particularly troublesome and in at least one case we have had an ammonia contaminated brine under control for several years without trouble of any kind.

Carbon dioxide leaks will cause rapid reduction of pH values and the practice of blowing out clogged lines with this gas can cause material corrosion damage. Air contact also introduces carbon dioxide and open brine systems will display marked tendencies for pH values to drop to dangerous points. Carbon dioxide is a corrosive and objectionable gas which should never be introduced into the brine. Its use for reducing pH values can only encourage carbonate scale formation or corrosion.

A brief explanation of the term pH may be of interest here. Atoms are generally conceived to consist of a positively charged nucleus surrounded by negatively charged electrons traveling in definite orbits. Atoms or groups of atoms which gain or lose electrons are said to be ions. Molecules of various substances disassociate into their component ions and the hydrogen ion is always present when acids disassociate. This is illustrated for hydrochloric or muriatic acid in the diagram. By measuring the hydrogen ion content of a solution we can determine its active acidity without reference to the particular acid or mixture of acids present.

The term pH is used to denote the quantity of hydrogen ion pres-

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DICHROMATE vs. CHROMIC ACID

(298.04)
$Na_2Cr_2O_7 \cdot 2H_2O + 2NaOH \longrightarrow$ (162 x2 = 324) $2Na_2CrO_4 + H_2O$
Sodium Dichromate — Sodium Chromate

(100.01)
$CrO_3 + 2NaOH \longrightarrow$ 162 $Na_2Cr_4 + H_2O$
Chromic Acid — Sodium Chromate

Based on these equations 66 pounds of chromic acid produce as much sodium chromate as 100 pounds of sodium dichromate but, because chromic acid is manufactured from sodium dichromate, it costs less to use 100 pounds of dichromate than 66 pounds of chromic acid (see cost comparison table)

BRINE TREATMENT COSTS

CALCIUM BRINE	
100# Dichromate at 7¼c	= $7.25 per 1000 Cu. ft.
66# Chromic Acid at 17c	= 11.22 per 1000 Cu. ft.
10# Quachrom Glucosate at 35.13c	= 3.51 per 1000 Cu. ft.
SODIUM BRINE	
200# Dichromate at 7¼c	= $14.50 per 1000 Cu. ft.
132# Chromic Acid at 17c	= 22.44 per 1000 Cu. ft.
10# Quachrom Glucosate at 35.13c	= 3.51 per 1000 Cu. ft.

ent in solution, a pH of one indicating maximum acidity and a pH of fourteen minimum acidity or in other words high alkalinity or causticity. The neutral point in the pH scale is seven but in corrosion control values above seven are usually needed and values of seven or below are usually very corrosive. In the case of brine it is desirable to carry pH values between 8.0 and 9.0. Above nine galvanizing may be attacked and below eight, iron and steel are attacked. An exception is calcium magnesium brine where pH values must be carried at seven or below to avoid precipitation of magnesium.

Scale and corrosion both occur in brine systems and scale and rust deposits exact their toll from operating efficiency, pile up high maintenance and depreciation charges, interrupt production and interfere with product quality.

The chrom glucosates offer efficient and economical control of brine corrosion and only 10 lb. of quachrom glucosate are ordinarily used per thousand cubic feet of brine. The exact quantity of inhibitor required will vary with the actual conditions of the brine system as corrosion products will react with the inhibitor and remove it from solution. This reaction is explained in detail in our reprint on the chrom glucosates.

Testing

Brine should be tested regularly for both pH and inhibitor contents and a simple drop testing outfit has been designed for use with the chrom glucosates which enables the engineer to determine his residuals quickly and accurately.

In all cases the application of corrective brine treatment should be based on analyses by a responsible laboratory and recommendations from a competent specialist. The indiscriminate and uncontrolled use of brine treatment does much harm and little good.

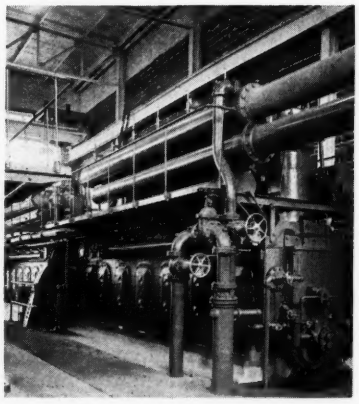
Gas Engines Show Low Cost Generation

DURING the early part of 1940, the Louisiana Ice & Electric Co. installed 3000 kw. of gas engine generating capacity in the Rea Station* at Bunke, La., making this the largest gas engine central station in the country. This capacity consisted of three Worthington twin six, 1500 hp. engines driving 1000 kw. Westinghouse generators and chain driven exciters. Two 540 hp. Worthington oil engines with 375 kw. generators in the original section of the station were retained for standby service. In May, 1940, the gas engine capacity was further insured by another Worthington engine driving a 1250 kw. G. E. generator.

In the first year of operation the original three gas engine units, operating with a 69.4 per cent running capacity factor, produced 13,545,500 kw. hr. of which 496,-117 kw. hr. were used in the station. This amounts to 3.66 per cent of the total generated, but this auxiliary power figure does not include the power requirements of the chain driven exciters. Gas consumption averaged 12.19 cu. ft. per net kw. hr., the mean valve of the gas running about 1148 and 1643 B.t.u. per cu. ft. for the higher and lower heating valves respectively. The gas cost averaged 4.99 ct. per thousand cubic feet.

Total production costs were $24,037.57 divided as follows: Supervision and labor, $9,554.60; fuel, $7,943.10; lubricating oil (3608 gal.), $1,747.24; water and miscellaneous, $1,726.90; maintenance labor, $844.25; maintenance material, $2,221.48. The costs in mills per kw. hr. of net generation these figures are respectively: (total) 1.842; 0.733; 0.608; 0.134; 0.132; 0.065; and 0.170.

Labor figures are somewhat higher than the true cost because, while the operators take care of the standby oil engine and ice plant machinery, no attempt has been made to pro rate these charges and they are all included in the gas engine plant costs. The employees consist of 7 operators and 2 maintenance men, the man hours being 17,441 for operation and 2,151 for maintenance. The availability factor of the three units was 97.6; 99.3 and 98.5 per cent.



One of the three twin-gas engine units in Rea Station. A year's operation shows a total cost per kw. hr. of 1.842 mills including fuel, labor and maintenance

Careful plant tests were made of all three units by means of a water rheostat made from 1 in. shafting suspended by means of a pulley arrangement in the sump of the cooling tower. Fuel consumption for full, three quarters and half load in B.t.u. (lower valve) per kw. hr. average for the three engines: 11,200, 12,143 and 15,666 respectively. Representative figures for the 12 hr. full load test (1003 kw.) on one unit with a generator efficiency of 95.10 per cent showed a brake horsepower load of 1,427 hp. and a B.t.u. consumption (lower) of 11,-530 per kw. hr. or 8,170 per hp. hr.

*For a complete description of the station see Gas Engines for Louisiana Utilities, by F. H. Coughlin, V.-P. Louisiana Ice & Electric Co., Alexandria, La. Power Plant Engineering, May, 1939, p. 298.

KIMBERLY-CLARK INCREASES POWER FACILITIES

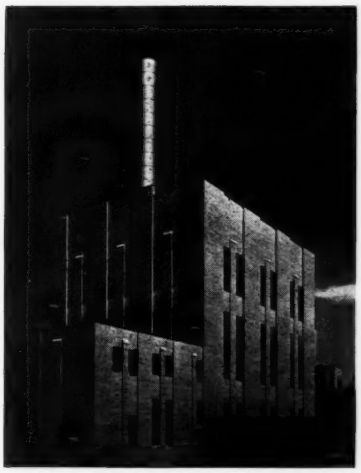


Fig. 2. The new boiler house. The extension at this end has offices on the second floor, the bark conveyor, sewage pumps, air receiver and heaters on the first floor. The ash hopper is at the far end of the main building over the railroad track

Steam and power generating facilities increased at Niagara (Wis.) paper mill by the installation of a 2000 kw. back pressure turbine in an existing mill building, to supplement hydraulic and purchased power, and two 90,000 lb. per hr. boilers in a new and separate boiler house. A feature of the installation is a new arrangement of bark burning furnace under the pulverized coal fired furnace

By W. L. LUNDY
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Neenah, Wisconsin

PRIOR TO THIS SUMMER all power used at the Niagara, Wis., mill of the Kimberly-Clark Corp. was obtained from hydro or purchased from the Wisconsin-Michigan Power Co. in accordance with the terms of an energy interchange contract. Steam was furnished by a low pressure plant, located between the sulphite and paper mills, and consisting of five stokers and two wood refuse burning boilers.

Future requirements combined with the need for maximum operating economy led to engineering studies. From these it was determined that the most economical combination for the steam and power extension would be new boilers, an operating steam pressure of 475 lb., 700 deg. F. and a 2000 kw. turbine, exhausting at 125 lb., 400 deg. F. to meet the requirements of the present equipment.

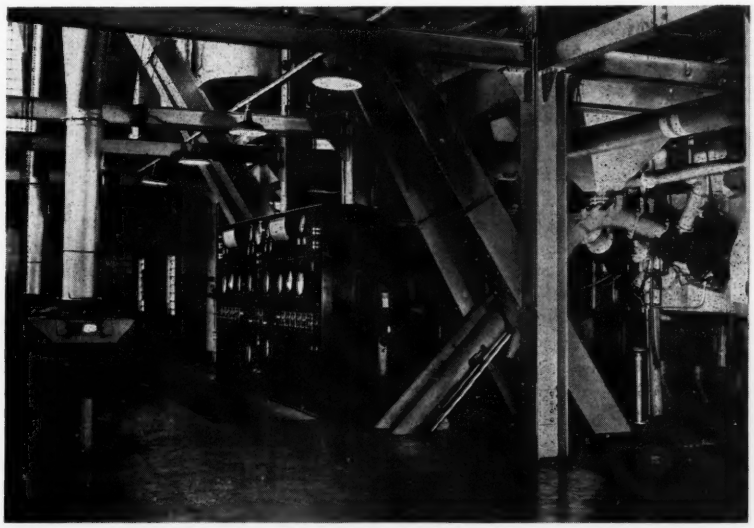


Fig. 1. Main firing aisle. Notice the round pulverized coal lines running diagonally from the floor at the end of the control panel to the burners and the square bark chutes crossing them at right angles and running to the bark furnace on the floor below. Coal feeders are at the extreme left

While space was available for the turbine, two new 90,000 lb. per hr. boilers, with space for a third future unit, made a new boiler advisable. This replaces the old boiler plant and is situated independently of the paper mill with a spur track for coal supply and ash removal.

As can be seen from Fig. 2, the building is of concrete, steel and brick construction with glass block windows on all sides except the rear. The main building dimensions are 90 ft. wide by 60 ft. deep by 80 ft. high. A two story office, locker room, shop and wood refuse conveyor building extension on one end is 47 ft. wide by 23 ft. deep by 30 ft. high.

Glazed tile walls and metalchrome colored floors form the building interior. The roof is of pre-cast concrete slabs with suitable openings for tube removal. A self-supporting gunnite lined steel stack 9 ft. in diam. and 75 ft. high has its foundation on the roof of the main building and the top is higher than any object within a 0.5 mi. radius.

At present the steam generating equipment consists of two 90,000 lb. per hr. steam generators with fin tube water cooled furnace walls, floor and roof; the boiler heating surface is 7090 sq. ft., and there is 2385 sq. ft. of water wall tubes. The superheater is both interdeck and intertube in

order to obtain 700 deg. F. steam from tubes placed in the space available in a standard design of boiler drum and tube arrangement. A tubular air preheater consisting of 600 2½ in. diam. tubes 30 ft. long provides preheated air at 500 deg. F. for the combustion of the pulverized fuel and wet wood refuse furnaces.

Each of the pulverized fuel furnaces has a volume of 5300 cu. ft., and the wood-burning furnaces proper have an additional 2800 cu. ft. This includes the combustion space behind the bridge wall, which also serves as an ash hopper for the pulverized fuel furnace.

The pulverized fuel furnaces were made somewhat larger than normal because of the combination fuel of coal and wood refuse. The resultant mixture of wood ash with ash from most of the eastern coals produces an ash of considerably lower ash fusion temperature than either the coal, or the wood alone. The larger furnace with the increased water wall surface results in a gas and dust particle temperature below the fusion temperature of the ash where the gases enter the boiler heating surface.

Returned condensate from the paper and pulp mill make up 70 per cent of the feedwater. The remaining feedwater makeup is treated from a combination sodium and hydrogen zeolite system. Daily tests of the resultant effluent from the mixture of the two kinds of water treatment are made, and the proportions are changed to obtain a water of zero hardness with the proper alkalinity to meet variations in the dissolved solids in the raw water.

Supplementary treatment with phosphate in the boiler is used to remove any residual scale-forming salts, which may enter the boiler either through contaminated condensate returns, or from the treatment system. The sodium zeolite system is a dual unit fully automatic but it is necessary to regenerate the hydrogen zeolite unit by hand operation. Sufficient treated water and condensate storage has been provided to take care of the maximum makeup water requirements during the regeneration periods.

For the heating of the feedwater two separate exhaust systems are installed. Turbines driving the induced draft fans exhaust at 10 lb. ga. and this exhaust is used in the low pressure deaerating heater and for heating the office section. Turbines driving the boiler feed pumps exhaust at 30 lb. ga., and this exhaust is used in the high pressure heater. A suitable cross-over line between the two systems, together with a high pressure line to the low pressure exhaust system is provided.

A system of reducing and relief valves is provided, so that should the pressure in the low pressure exhaust system fall below 6 lb. ga., steam flows from the high pressure exhaust system to the low pressure system. Should the pressure continue to fall to 4 lb. ga., an additional reducing valve in the high pressure line provided steam for proper deaeration in the low pressure heater.

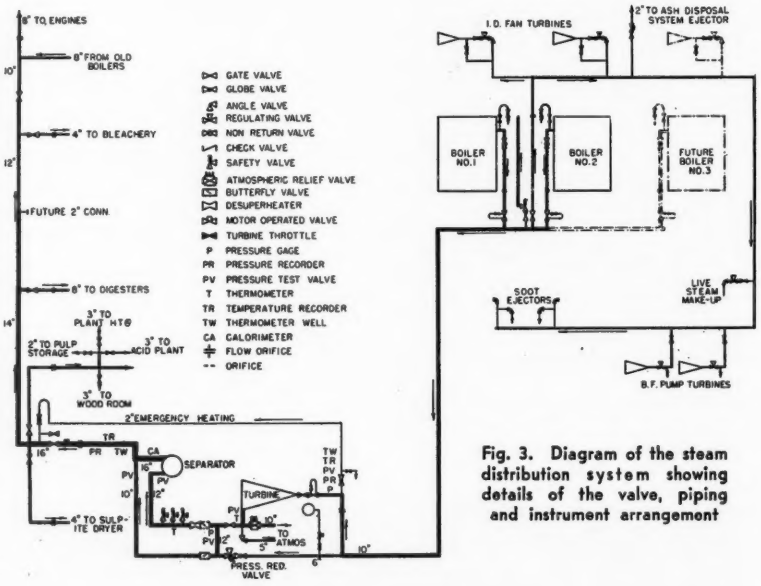


Fig. 3. Diagram of the steam distribution system showing details of the valve, piping and instrument arrangement

Relief valves to atmosphere are provided in each of the exhaust systems. These are pilot valve operated, and are arranged so that the high pressure makeup valve will not open if the low pressure relief valve is opening.

Coal Handling Equipment

Coal is delivered to the plant in high hopper gondola cars, dropped into a track hopper and removed from the hopper by a Redler conveyor elevator, which conveys and elevates the coal to a second cross conveyor on the coal bunkers. Coal bunkers have a capacity of 120 t. for each boiler with space available for an extension in front of the future boiler. The coal handling equipment has a capacity of 50 t. per hr. at a speed of 70 ft. per min.

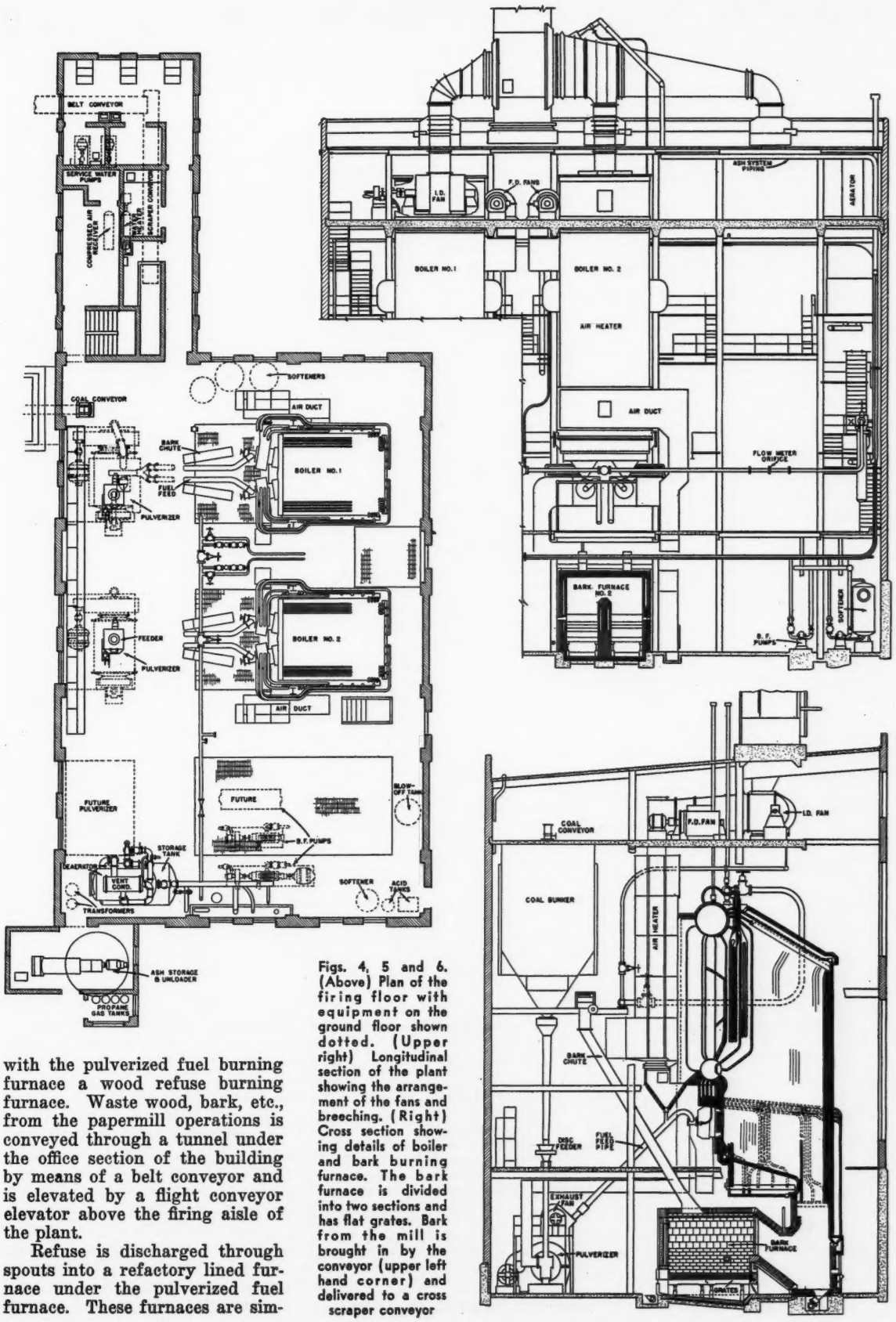
Coal handling equipment in the plant has been so designed to eliminate coal dust leakage between the track hopper and the feeder of the pulverizing mill. The top of the coal bunker is sealed by the fan floor with a suitable vent through the boiler house roof.

Pulverizing and burning equipment for each steam generating unit consists of a raw coal feeder, ball mill pulverizer, exhauster fan and two burners with connecting piping. Coal flows by gravity, from the overhead bunker into the disc feeder, located on the operating floor and driven by a variable speed slip ring motor. The speed is controlled by an electronic device which maintains a predetermined coal level in the mill.

From the disc feeder coal falls by gravity into the pulverizer located on the main floor. The exhauster is located on a steel supported patform above the pulverizer. The two burners are located in the furnace wall under the boiler mud drum. They are mounted in the air ducts, which has been arranged to provide individual damper control, and as nearly the same secondary air pressure in each burner box over the full range of operation, as is practical to obtain.

Refuse Burning Furnaces

As can be seen in Figs. 5 and 6 each boiler unit has in connection



Figs. 4, 5 and 6. (Above) Plan of the firing floor with equipment on the ground floor shown dotted. (Upper right) Longitudinal section of the plant showing the arrangement of the fans and breeching. (Right) Cross section showing details of boiler and bark burning furnace. The bark furnace is divided into two sections and has flat grates. Bark from the mill is brought in by the conveyor (upper left hand corner) and delivered to a cross scraper conveyor

with the pulverized fuel burning furnace a wood refuse burning furnace. Waste wood, bark, etc., from the papermill operations is conveyed through a tunnel under the office section of the building by means of a belt conveyor and is elevated by a flight conveyor elevator above the firing aisle of the plant.

Refuse is discharged through spouts into a refactory lined furnace under the pulverized fuel furnace. These furnaces are sim-

LIST OF PRINCIPAL EQUIPMENT

BOILER ROOM

Steam generators, water walls, superheaters, boiler casing and insulation—Combustion Eng. Corp.
Pulverizers, feeders and burners—Kennedy Van Saun Eng. & Mfg. Co.
Turbines for fan and pump drives—Terry Steam Turbine Co.
Induced and forced draft fans—American Blower Corp.
Service water pumps and motors—Allis Chalmers Mfg. Co.
Boiler feed pumps—Ingersoll-Rand Co.
Coal conveyors and equipment—Stephens-Adamson Mfg. Co.
Ash and dust handling equipment—United Conveyor Corp.
Wood refuse conveyors—Chain Belt Co.
Deaerating heater—Hoppes Mfg. Co.
High pressure heater—Alco Products Co.
Stack and dampers—Connery Construction Co.
Air and gas ducts—Vulcan Mfg. Co.
Refuse furnaces—Furnace Economy Co.
Motors and control equipment—General Electric Co.; Westinghouse E. & M. Co.
Feedwater regulation—Swartwout Co.
Panel boards, meters and combustion control—Bailey Meter Co.
Draft gauges, gas analyzers, smoke density recorders—Hays Corp.
Conductivity indicators—Leeds & Northup Co.
Temperature recorders—Bailey Meter Co.; Bristol Co.
Indicating gauges—Crosby Steam Gauge & Valve Co.
Indicating thermometers—American Schaeffer & Budenburg Corp.
Soot blowers—Diamond Power Specialty Corp.
Blow-off tank—Struthers-Wells Co.
Safety valves—Crosby Steam Gauge & Valve Co.
Piping—Pittsburgh Piping & Equipment Co.
Insulation—Owens-Corning Corp.
Valves—Crane Co.; Edward Valve & Mfg. Co.
Surge tanks—Leader Iron Wks.
Laboratory equipment—Kewaunee Mfg. Co.
Feedwater treatment—Permutit Co.
Float control and relief valves—Fisher Governor Co.
Pressure reducing and damper operating equipment—A. W. Cash Co.

TURBINE EQUIPMENT

Turbo-Generator—Westinghouse Elec. & Mfg. Co.
Pressure reducing and desuperheater control—Swartwout Co.
Meters—Bailey Meter Co.
Desuperheater pumps—Ingersoll-Rand Co.
Receiver-separator—Struthers-Wells Co.
Purifiers—Hagen Corp.
Piping—Pittsburgh Piping & Equipment Co.
Valves—Crane Co.; Edward Valve & Mfg. Co.
Expansion joints—E. B. Badger & Sons Co.

ilar to the old dutch oven type furnaces, but have air cooled walls in the combustion section and hollow walls in the retort section. The grates are flat of special design for shaking and dumping. A flat suspended arch with a drop nose over the bridge wall forms the roof.

Flat Grates

Grates in each half of the furnace are 5 ft. wide by 12 ft. long, and in order to distribute the wood refuse through a single spout over the full length of the grate, the inertia of the refuse sliding down the spout is utilized to throw it to the back of the grate. A swinging deflector plate, which hangs in front of the spout discharge, is used to spread the bark over the entire length of the grate. The deflector plate is mounted on a shaft, which rotates by a hydraulic cylinder through a suitable lever arm. The speed of the deflector plate can be regulated, or it can be stopped in any desirable position.

Air from the air preheater is passed through the hollow walls, where the temperature is raised from 500 deg. F. to approximately 700 deg. F., and directed on to the pile of rufuse on the grates through special ported tile. Eighty per cent of the air for combustion is admitted in this manner, and 20 per cent either under the grates, or through openings in the arch, and bridgewall.

Gases resulting from the burning of the wood refuse passes into the pulverized fuel burning furnace through a throat formed between the end of the floor tubes and the back water wall tubes.

The feature of this design is that a large refactory furnace is provided with highly preheated air for cumbustion of the wet refuse received from the wood room. This assists in evaporation of the large quantities of water present in the refuse and raises the furnace temperature to aid combustion. The furnace is designed to burn 17,000 lb. per hr. of 60 per cent moisture refuse.

Other features of the design provides for a large percentage of over fire air, and the combined furnace causes all of the charcoal and partially burned wood to pass through the pulverized fuel furnace where combustion is completed. With the gases from the wood burning furnaces entering the pulverized fuel burning furnace at the target wall, no interference obtains between the combustion of the two fuels.

Ashes and refuse from the pulverized fuel furnace, the soot hoppers between the boiler and air heater, and the wood-burning furnace is conveyed to a tile tank on the west side of the boiler room by means of a pneumatic conveyor. The refuse from the ash storage tank is removed through a "dustless unloader" either to railroad cars or trucks as desired.

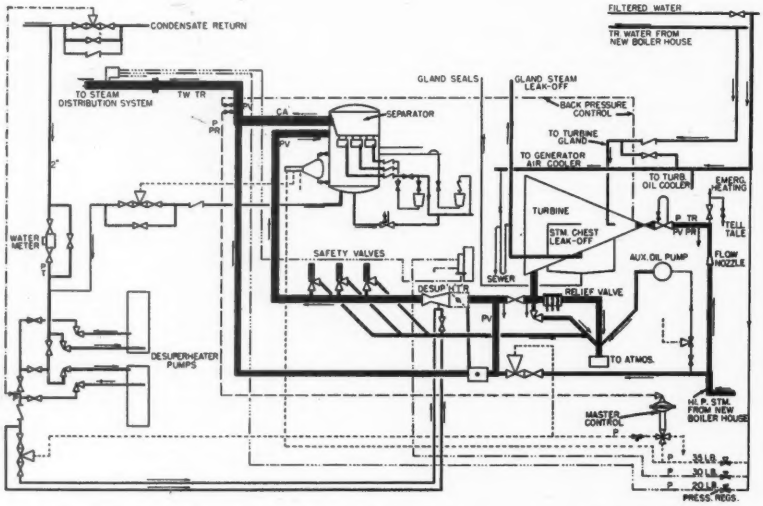


Fig. 7. Details of the reducing valve and desuperheater arrangement at the turbine

Meters and Combustion Control

A full complement of meters and control equipment are installed so that a complete record of all the various operations, connected with the burning of the fuel and making of the steam, is obtained. Recording and indicating thermometers for determining the performance of all equipment are installed. Meters for measuring steam produced, steam used, feedwater used, water treated, etc., are installed.

A compressed air actuated hand, or automatic combustion control system is installed. All controllers for the dampers and fuel supply are located on the

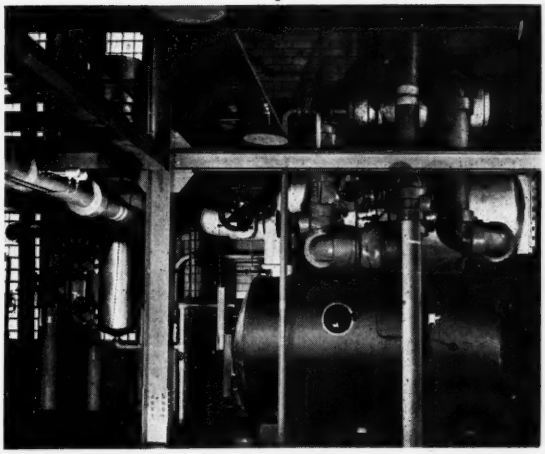


Fig. 8. Storage tank, deaerator, vent condenser and high pressure heater are arranged against one end of the boiler room. The boiler feed pumps are directly below on the ground floor

operating floor, and may be operated by hand, if the air supply should fail. A carbon ring air compressor provides air for control operation with a reducing valve connection to the paper mill air supply should the compressor fail.

As arranged, the furnace pressure controls the steam to the induced draft fan turbines to maintain a constant furnace draft. Steam pressure positions the fuel and air supply with another controller operated through a ratio controller to adjust the fuel supply in accordance with the secondary air supply. A hand adjustable constant volume controller controls the air to the bark burning furnace. A constant air pressure controller controls the inlet vanes to the forced draft fan.

Suitable electrical interlocking is provided for proper sequence of equipment operation when firing is started. This interlocking also shuts down the equipment in proper sequence upon failure of any of the equipment.

Ignition by Propane

Initial ignition of the pulverized fuel is obtained by bottled propane gas. The valves are electrically operated and the gas is ignited by spark plugs. This equipment is also interlocked with the pulverized fuel burning equipment so that sufficient gas pressure must exist in the line, and the gas valves must be open before any firing equipment can be operated.

Automatic gas analyzers and smoke density recorders are installed. These are recorded on the same chart, so that a full picture of the combustion process is obtained.

Conductivity indicators for determining boiler water concentration for control of blow down are installed, also conductivity indicators for steam quality are installed. Coal meters in the coal piping between the bunker and feeders are used to determine the coal consumption. Feedwater pressure and boiler water level controllers are installed for feedwater regulation.

Other equipment essential for a complete boiler plant is installed, such as boiler feed pumps, service water pumps, condensate pumps, air filtering and cleaning equipment, bilge pump, shop equipment, etc. In order to obtain a heat balance between exhaust steam required for feedwater heating, one of the 300 g.p.m. pumps is dual driven with a motor on one end, and a turbine on the other end. The turbine speed is controlled by the exhaust steam pressure with the motor supplying the power for driving the pump when and if required for maintaining feed line pressure. The other feed pump is turbine driven and the speed is controlled by the feed line pressure.

Piping

All piping in the boiler room, and the main steam line to the turbine room, as well as condensate return lines, treated water lines, etc., is of welded construction. A feature of the piping layout of the boiler plant is that traps were eliminated except on the radiators in the office section heating system.

Turbine Room

The turbo-generator installation, located in the paper mill 500 ft. from the boiler room, insures a continuous supply of power during low water periods and during tie-in disturbances during electrical storms. This is a 2000 kw. unit with a direct connected exciter. The turbine receives steam at 475 lb. ga., 700 deg. F. and exhausts at 125 lb., 400 deg. F., the mill operating pressure.

A desuperheating station is installed in connection with the turbine installation and steam, from the turbine as well as that bypassing the turbine through the reducing valve, is handled by the desuperheater. A mixture of condensate and zeolite treated water is used for desuperheating. An excess is used for desuperheating part of the steam to complete saturation with the excess water being in a receiver-separator by purifiers. The temperature of the steam is again raised to 400 deg. F. by by-passing part of the high temperature steam from either the turbine exhaust, or from the reducing valve around the turbine.

The turbine governor may be operated on hand control back pressure control, or load limiting control, or a combination of the latter two. The desuperheater operation is fully automatic, with the exception of the water required for desuperheating the exhaust from the turbine. This

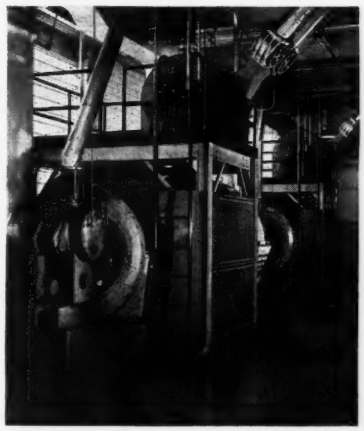


Fig. 9. Ball mill coal pulverizers are located on the ground floor, with the exhausters on a platform immediately above

water quantity is always in excess of that required for desuperheating. The excess is pumped back into the desuperheater through a float controlled valve.

The plant was designed by the Staff Engineering Department of Kimberly-Clark Corporation, and erected under the supervision of the Engineering Department.

Fig. 1. I. E. Moultrop, Chairman of the Advisory Committee, and Charles F. Roth, Manager of the Exposition, discuss plans for the coming show. In addition to Mr. Roth, the advisory body, consists of 18 well known engineers, 6 of whom served on the first committee back in 1922. They are: I. E. Moultrop, John H. Lawrence, Homer Addams, Fred Felderman, David Moffatt Meyers, Charles F. Roth. The other 13 members are: Comfort A. Adams, J. T. Barron, R. E. Dillon, A. C. Fieldner, N. E. Funk, F. E. Giesecke, G. E. Hulse, George L. Knight, Joseph Pope, Arthur L. Rice, E. K. Stevens, Philip W. Swain and Alfred Vaksdal

THE POWER SHOW—

PAST AND PRESENT

POWER PRODUCTION, better than any other single item, serves as an acceptable index of national conditions. It is a common denominator which at one and the same time measures the material progress of the National Defense program, production of normal industrial and domestic necessities and the prosperity of the above nation, a nation made up of: labor that utilizes industrial power; workers that carry on the auxiliary services of a complex civilization that makes industry possible; and all dependents of both groups.

It is an instantaneous index, for, says Irving E. Moultrop, grand old man of the power industry and father of high pressure plants, "Power production always balances consumption since there are no mass reservoirs for storing light, heat and power. Power production capacity must outrun the current demand and be based on estimates of future load growth. This planning has made it possible for the industry to pick up the load this year and it is even now planning reserve capacity several years ahead."

With manufacturing capacity in the country expanding at an unprecedented rate, planning for the future is more important than ever for the engineers of both utility and industrial plants generating their own power. This will involve the construction of many new plants and the rehabilitation of many others.

So far there has never been a major power shortage. At the same time there has never been such an unprecedented demand for power as is indicated during the next two or three years. An engineer must figure, plan and work on new services of power, more efficient layouts or new and improved equipment for from 1 to 5 yr. before the new capacity is available so the need for detailed consideration of future power needs is imperative.

It is reasonable, therefore, to expect a great stimulation of replacement sales of steam power plant equipment for many of the smaller plants, as well as motors, wiring, switches, meters and other electrical equipment in connection with increases in the application of purchased power by many others.

Since every power plant consists of a chain of process-events, stretching from the coal pile to the gate valves in the process steam lines or the bus-bars at the main switchboard, it follows that to strengthen the "weakest link" in the chain is, in effect, to enlarge the capacity of the plant. With this principle in view, thousands of engineers are studying the possibilities of partial equipment replacements, and are keenly interested in the new items that will be revealed at the power show next week, held during the convention period of the A.S.M.E.

Preparedness

This year the show is particularly timely, for, as C. F. Roth, the manager, says: "Preparedness should be thought of as a state of mind. It is an attitude bred in the professional training of the engineering fraternity. To this may be chiefly ascribed the start and growth of the National Power Show, as it is conversationally known."

The history of this particular power show is interesting. It really goes back to 1915 when the First Exposition of Chemical Industries was held in New York, under world conditions strangely reminiscent of the present. With the rapid increase of power during this period the power section soon reached the stage where it dominated the Chemical Show.

In reporting the 7th Annual Exposition of Chemical Industries held in the 8th Coast Artillery Armory, New York City, in September, 1921, POWER PLANT ENGINEERING said: "Friday's sessions devoted to the power plant in the Chemical Industries was the most

successful day of the week as far as attendance and enthusiasm were concerned." The attendance was given as 50,000.

The Start

The importance of the power section in the show led to the suggestion that the power section be set up on its own foundation. Accordingly an advisory committee of prominent engineers was formed with I. E. Moultrop, of the Edison Electric Illuminating Co. of Boston as Chairman. He still holds that office. Altogether six of the original committee are still active after almost 20 yr. The names of these six, together with the other members of the present committee, are given in the caption of Fig. 1.

As a result of the recommendation of that body, the National Exposition of Power and Mechanical Engineering was organized and the first show was held in Grand Central Palace in December, 1922. In reporting that show POWER PLANT ENGINEERING said: "The exhibitors were fully alive to the interest which is being manifest by engineers in apparatus which will improve plant operation and conserve fuel . . . The exhibitors, management and executive committee are to be commended for the high standard set at which, we hope, may only be the first of such exhibitions."

Broadened

While the name covers a wide range of equipment, the show has always been preponderantly a "power show" and is seldom called anything else by engineers. The first show had 90 power exhibits out of 120, the second in 1923 had 160 out of 270.

At the fourth show in 1924, the equipment range was further broadened by the addition of hydraulic turbines, which, however, were destined to play but a small part in future shows. The important thing about the fourth show was expressed editorially by POWER PLANT ENGINEERING as "exhibitors had profited immensely by the experience of previous shows. . . . Much actual equipment destined for some prominent plant in actual operation . . . (the show has) become a meeting place where the printed page has become animated."

This trend toward exhibiting actual equipment destined for some prominent plant, usually a central station, became more pronounced in later years until the depression stopped practically all construction and forced a change in the character of the exhibits.

Steady Increase

The size of the show continued to increase steadily until the seventh show in 1928 at which there were approximately 700 exhibits on four floors of the Palace. The attendance for several years fluctuated between 100,000 and 125,000 visitors. In 1929 the show reflected falling business conditions and the number of exhibits dropped to 420.

Due to the depression and conflict with the Chicago Power Show, which started up in 1926 around the Midwest Power Conference, the Ninth New York Show in 1930 was the last annual one. Thereafter they have been held biannually, alternating with the parent exhibition of the chemical industries.

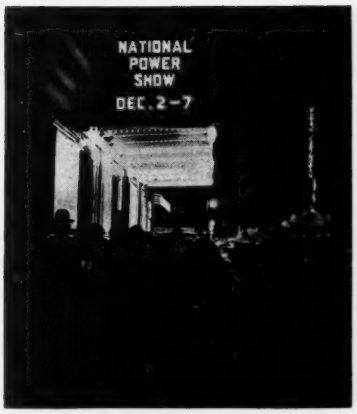


Fig. 3. Although it seems like a busman's holiday, the engineers' night (or at least early evening) life in New York will center in Grand Central Palace next week. Technical sessions at the A.S.M.E. convention keep the out of town visitors occupied during the day, but they throng the exhibits in the evening. The show closes at 10 p. m., long before the lights of nearby Broadway are burning brightest

The tenth show in 1932 at the depth of the depression was not the largest but was outstanding for the variety of new equipment. Manufacturers had made good use of the slack business period to develop new ideas and put them on the market. In connection with this show POWER PLANT ENGINEERING said:

"Probably at no past show was there exhibited such a variety and quantity of absolutely new equipment." In connection with the shift of interest from preponderantly central station equipment the report continued: "(exhibits) aimed directly at the small plant and central station equipment as a unit of the industry were practically eliminated."

Continued on a biannual basis, the 1940 show will be the fourteenth. From advance reports it should be as spectacular as the first and the tenth. During the last decade the entire course of power plant practice has changed. With industry undergoing a tremendous inflation and power demands increasing proportionately, the planning job of the engineer is pretty well outlined. Nowhere else can the engineer so easily and in so short a period become familiar with new and improved products, some so new that details of the exhibits were finished too late for preshow announcements.

Fig. 2. Through experience exhibitors have found that visitors take greatest interest in moving displays, preferably something they can work themselves

PAINTING ACOUSTIC MATERIALS

Tests show that a number of paint coats can be applied to most acoustic or sound absorbing materials without decreasing their effectiveness. In general a spray is superior to a brush.*

ONE OF THE serious maintenance problems where acoustic treatment has been used is that of cleaning and redecorating. This is particularly true where indirect lighting is used, as a dirty ceiling decreases the illumination by a considerable amount. It has been found that when the materials are clean, that is, when the pores are not clogged with dirt, a number of coats of paint can be applied on many materials without seriously decreasing their sound absorption.

If similar results are to be obtained on material which has been installed for several years, the dust should be cleaned thoroughly from the surface before the paint is applied. A large number of the materials which are now sold as acoustic materials depend to a considerable extent for their sound absorption on the porosity of the materials. A few of these materials have very large pores which are so interconnected that the sound absorption can be increased to a limited extent by partly closing the pore openings at the surfaces.

Porosity

Other materials have small openings which are not so well interconnected, with the result that the sound absorption is decreased as soon as any of the pore openings are closed. Owing to these differences, the effect of a coat of paint in changing the absorption due to porosity varies considerably for different types of material. For instance, a material with large pores may have the absorption increased by the first few coats of paint, but finally a stage will be reached where the absorption begins to decrease. The point where this loss in absorption begins depends upon the frequency of the sound, always showing up first at the higher frequencies.

Materials with small pores which are not intercommunicating may have a considerable number of pores closed with the first coat of paint. In this case one would expect to find a decrease in the sound absorption of the material on painting.

Sound may also be absorbed by setting the material into damped vibration as a diaphragm, the more the damping the greater being the absorption. Likewise, a soft material may absorb sound by inelastic yielding. When the sound is absorbed by one of these methods, the effect of paint is quite different from that when it is applied to a material where the absorption is entirely due to porosity.

Damped Vibration

When the absorption occurs in a soft material because of an inelastic yield, this can be taken as a special case of a damped vibration of a diaphragm—that is, the natural frequency has approached zero. Today it is seldom that a material of this type is found, but a few years ago a very common treatment was hair felt on which was glued a painted membrane. After a few coats of paint were applied, the pores were completely sealed. Under these conditions most of the absorption was due to an inelastic yield of the felt. In this case additional coats of paint increased the weight and stiffness of the surface membrane and, as a result, decreased the absorption of the material.

Spray vs. Brush

It appears that approximately the same results are obtained whether a cold-water casein paint or an interior flat paint is used. The paint used in each case was a flat white interior oil paint and is one of the well-known brands of interior paint. When the paint was applied with a brush, it was thinned slightly by adding 10 per cent of turpentine by volume, with the exception of Sample 7. In this case 25 per cent of turpentine by volume was added. When applied with a spray gun, the paint was thinned by adding 50 per cent of turpentine by volume.

It is apparent that the manner in which the paint is applied is of considerable importance, except for materials having a perforated surface with the perforations so large

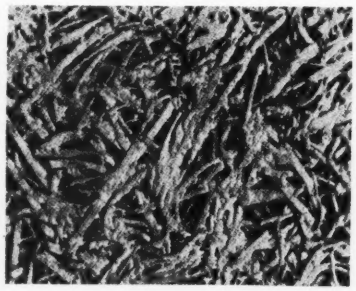


Fig. 1. Surface appearance of samples 1 and 2 unpainted and magnified 1⅔ times

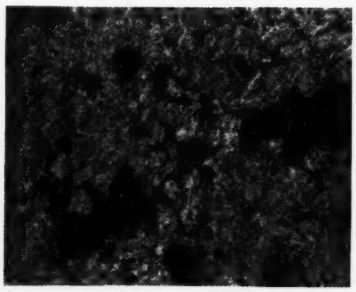


Fig. 2. Surface appearance of sample 3 unpainted and magnified 1⅔ times

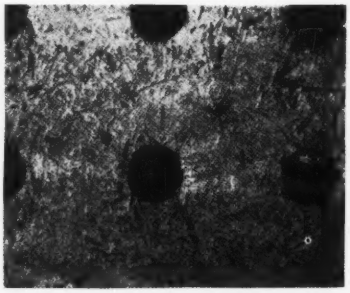


Fig. 3. Surface appearance of sample 4 unpainted and magnified 1⅔ times

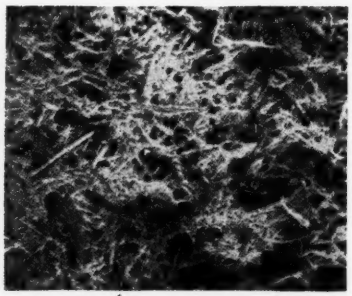


Fig. 4. Surface appearance of sample 5 unpainted and magnified 3 times

*Based on research conducted at the National Bureau of Standards and reported by V. L. Chrisler in Research Paper RP1298. Federal Specification SS-A-118 mentioned in the test can be obtained for 5 ct. per copy from the Superintendent of Documents, Washington, D. C. RP1298 complete can be obtained from the same source for 10 ct. per copy.

that the paint will not film across the openings. For other materials to which the paint should be applied as a fine spray and the quantity applied should not be sufficient to film across the fibers or grains in the acoustic material so as to form a solid film.

A similar situation exists when the paint is applied with a brush. The paint should not be excessively thick and it should be applied in such a manner as to film across the pores as little as possible. A much better painting job, as far as appearance is concerned, can be done on most acoustic materials with a spray gun, and as a rule the sound absorption is decreased by a smaller amount when the paint is applied with a spray gun than when applied with a brush. Table I gives the sound absorption coefficients of several materials before and after painting.

Samples 1 and 2 are representative of materials made from a wood fiber similar to fine excelsior. They comply with the requirements in Federal Specification SS-A-118* for Type VII.

Sample 1a absorbs considerably less sound at the higher frequencies than the unpainted sample. The most surprising result is the decided increase of absorption at 512 c.p.s. It would appear that this type of material has a structure in which the space between the fibers are so open and intercommunicating that a maximum absorption can be obtained at this frequency by partially closing the surface pores. Such a statement is not true for most of the other types of materials. Sample 2 is the same as sample 1 but was painted by the manufacturer.

Incombustible

Sample 3 is one of the incombustible materials of Type VI as described by Federal Specification SS-A-118. Sample 4 is representative of the material described as Type V in Federal Specification SS-A-118. Sample 5 is a material which is classified as Type VIII in Federal Specification SS-A-118. Spray painting gives a much better appearing material than does brush painting. In fact, this is true of all of the materials discussed, except Samples 3 and 6.

Sample 6 is a material which has been classified as Type VI in Federal Specification SS-A-118. This material was painted by the manufacturer.

Samples 7 and 8 are of an acoustic material which is applied with an air gun. It is of such a nature that it can be applied to give a number of different surface textures. Both these samples were applied directly on metal lath. For the unpainted sample the absorption must take place by all three methods discussed in the first part of this paper, as the material is porous, soft, so that it yields easily to the sound pressure, and relatively thin and light, so that it vibrates easily as a diaphragm.

Sample 9 is representative of

Sample	Surface finish	Sound absorption coefficients at frequencies (cycles per second)—						Noise coefficients
		128	256	512	1,024	2,048	4,096	
1	Unpainted	0.09	0.24	0.62	0.89	0.73	0.73	0.60
1a	Brush painted 5 coats	.14	.49	.83	.61	.30	.22	.55
2	Painted by manufacturer	.07	.22	.54	.87	.78	.77	.60
2a	Brush painted 5 additional coats	.09	.27	.71	.92	.62	.62	.65
3	Unpainted	.11	.29	.78	.84	.75	.63	.65
3a	Brush painted 5 coats	.12	.42	.81	.74	.61	.49	.65
4	R. I. finish	.10	.30	.78	.85	.59	.42	.65
4a	Brush painted 4 coats	.08	.33	.83	.86	.53	.37	.65
5	Unpainted	.14	.51	.78	.78	.78	.82	.70
5a	Spray painted 7 coats	.18	.50	.79	.74	.71	.67	.70
5b	Brush painted 5 coats	.25	.41	.61	.47	.34	.36	.45
6	Painted by manufacturer	.07	.25	.70	.63	.53	.63	.55
6a	Brush painted 4 additional coats	.11	.33	.66	.45	.31	.39	.45
7	Unpainted	.54	.87	.78	.73	.78	.75	.80
7a	Brush painted 6 coats	.56	.78	.70	.54	.53	.59	.65
8	Painted by manufacturer	.57	.71	.80	.56	.51	.52	.65
8a	Brush painted 4 coats	.58	.76	.51	.28	.25	.13	.45
9	Painted by manufacturer	.13	.40	.68	.63	.60	.68	.60
9a	Brush painted 5 additional coats	.20	.26	.31	.22	.18	.23	.25

Table I. Sound absorption coefficients of test panels. Gallons of paint (mixed as described in the text) used per 1000 sq. ft. of surface varied from 2.6 to 9.5 gal. for the first coat and decreased gradually to from 2.2 to 3.5 gal. for the fourth coat when applied by brush. With spray painting the requirements stayed relatively constant at about 4.0 gal. per coat. From 4 to 5 coats were needed to hide a black strip

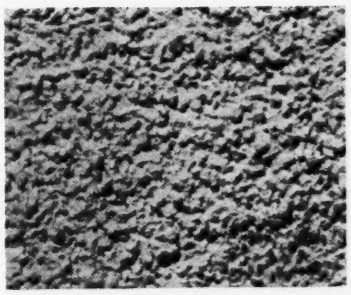


Fig. 5. Surface appearance of sample 9 unpainted and magnified 1⅔ times

Type II materials as described by Federal Specification SS-A-118. The surface texture is similar to that of most of the acoustic plasters and the absorption is largely due to the porosity of the material. After a few coats such a material will film across with a resulting loss in absorption.

Paint Application

The materials on which results are given are quite representative of most of the acoustic materials which are on the market at the present time. Some of these materials can be painted with only one or two coats before there is a noticeable decrease in the second absorption of the material, whereas other materials can be painted many times before the acoustic properties of the materials have been decreased. In practically all cases, however, considerable care must be taken as to how the paint is applied.

If the paint is thinned to some extent before being applied and each coat is applied thin enough so as not to form a film across the surface, the principal factor which affects the decrease in absorption is the amount of pigment that is deposited on the surface. When a thin coat of paint is applied, most of this pigment is deposited on the top and sides of the surface particles or small projections on the surface of the acoustic materials. Additional coats continue to build up this amount of pigment. When the pore openings are very small, one or two coats may be sufficient to build this pigment deposit across the opening. When the pore openings are larger, more coats of paint are required before this deposit of pigment will close the openings.

It is possible to obtain a more uniform coating of the surface particles or projections when the paint is applied with a spray gun than when applied with a brush; likewise, more coats of paint are required before the pigment builds across the pore openings.

How To Estimate Capacitors

By HAMILTON BROOKS
Capacitor Engineer, Switchgear Engineering Department
Westinghouse Electric & Manufacturing Co.

CAPACITORS for power factor improvement can be simply estimated with sufficient accuracy for most industrial installations. A series of involved mathematical calculations are not required if it is recognized that the problem is primarily that of supplying leading reactive kv-a. by means of capacitors to compensate for the lagging reactive kv-a. used in magnetizing the induction motor and transformer fields. In considering the problem from this angle, the intangible term "Power Factor" enters into the picture mainly as a factor for measuring the final results of the capacitor installation.

The reason for this is made clear by a brief analysis of electrical power rate schedules. The primary item in a power bill is, of course, the "Energy Charge" as measured by the kw-hrs. consumed. Of next importance is the "Demand Charge" which is determined by the peak load and usually measured as the highest kw. recorded for any 15 minute period during the month. These two charges and the way they can be controlled by plant operation are easily understood.

A third important item and its effect on the total billing is often overlooked. This is the so-called "Power Factor Clause." Not showing directly as an item in the belling, the factors affecting it are more obscure and require a closer study of the rate schedule. In some schedules low power factor is penalized through adjustment of the energy charge. In others, through adjustment of the demand charge. Some schedules bring the charge into the billing through a multiplier determined from the relation of kw-hr. to reactive kv-a. hour, while others offer a bonus for power factor improvement through a discount on the net billing. Whatever the method of calculating the power factor charge, however, a power factor clause in the schedule simply means that if the customer requires a large amount of reactive kilovolt-ampere-hours in proportion to the kilowatt-hours consumed, it is necessary for the power company to charge for this service. Since this is so, the easy approach to a power factor correction problem is from the standpoint of reactive-kilovolt-ampere-hours.

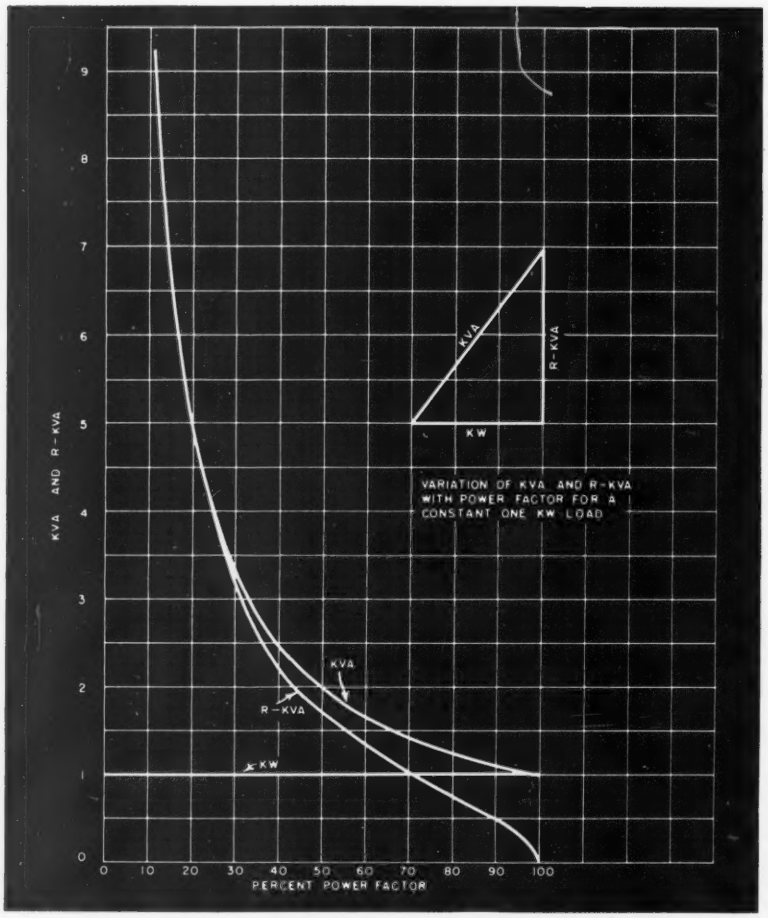

KVA AND R-KVA
PERCENT POWER FACTOR
0 10 20 30 40 50 60 70 80 90 100
0 1 2 3 4 5 6 7 8 9
KVA
R-KVA
KW
VARIATION OF KVA AND R-KVA WITH POWER FACTOR FOR A CONSTANT ONE KW LOAD
KVA
R-KVA
KW

Fig. 1. Relations between Kw., R-kv-a. and total kv-a. for different power factors

Range of Capacitor Values

There is a wide range in capacitor kv-a. values that will give satisfactory correction on a particular job. The curves in Fig. 1 show the relation between kw., R-kv-a. and total kv-a. for different power factors. As an example, take the case of a capacitor required to improve the power factor of one kilowatt load which has 70 per cent power factor initially. For an industrial installation, correction to any value between 90 and 100 per cent will ordinarily give the desired savings in the power bill.

For Power Factor Improvement

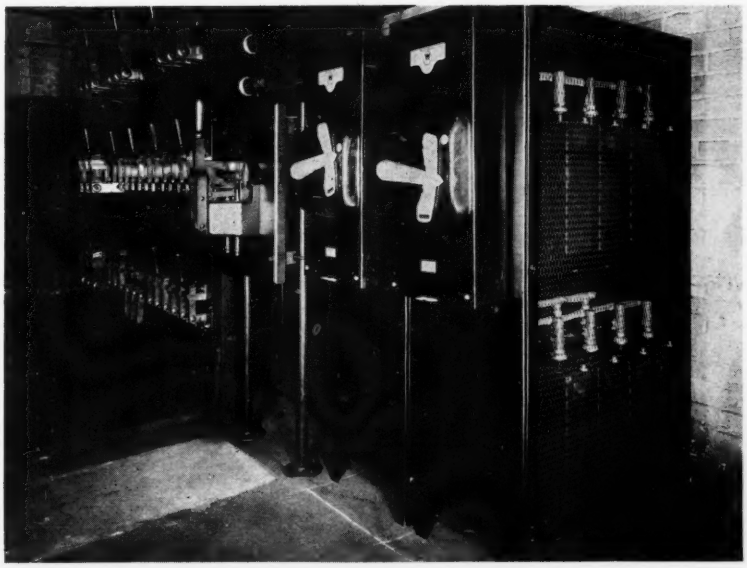


Fig. 2. A capacitor installation in an industrial plant

Figure 1 shows that a one-half kv-a. capacitor will correct the one kw. load to 90 per cent, while a one kv-a. capacitor corrects to 100 per cent. A capacitor with a rating of any kv-a. value between one-half and one should, therefore, be satisfactory. Considering a more specific example, Table I gives the variation of power factor with load for a typical induction motor. It will be observed that the power factor varies from 12.3 per cent at no load to 89 per cent with a 25 per cent overload. On the other hand, the reactive kv-a. of this 25 hp. motor shows a change of only 5 kv-a. up to 25 per cent overload. The effect of a 5 kv-a. capacitor connected to the motor terminals is to bring the power factor to 95 or 96 per cent over the important operating range, yet a 10 kv-a. capacitor does not over-correct the motor, as resulting power factor is practically unity for a wide range of loads.

The selection of capacitors on the basis of individual motor requirements works very well for small installations. For large power users, however, this is likely to give more capacitor kv-a. than is needed. Just as a small continuous load can account for a sizable portion of the kw-hrs. registered during a month, so a small capacitor operated continuously may cause a large reduction in reactive-kilovolt-ampere hours recorded. Since power factor for billing purposes is nearly always an average determined from the total reactive-kilovolt-ampere hours, the continuous operation of a small capacitor has an important effect, as long as it is not allowed to exceed the inductive load or produce a leading power factor. Any excess capacitor kv-a. that results in leading power factor is ineffective because of the common practice of ratcheting the R-kv-a.-hr. meter to prevent it from turning backwards.

Importance of Small Reactive Loads

To illustrate the importance of small continuous reactive loads and their correction, consider the case of a moderately large consumer who receives power through a 2,000 kv-a. transformer bank and which is metered on the primary side. Assume such a bank to have reactance of 3.6 per cent or to require 72 reactive kv-a. for magnetizing. If the bank is connected continuously in order to supply small night and week end loads, it will account for 72 R-kv-a. × 740 hr., or 53,280 R-kv-a.-hr. per month. This reactive kv-a. would be entirely eliminated by a small capacitor of 72 kv-a., or reduced to only 8,800 reactive-kilovolt-ampere hours by a 60 kv-a. capacitor or the nearest standard rating.

The use of these principles in estimating capacitors is best shown by an example, and using the requirements of a typical manufacturing plant of moderate size:

Power is supplied at 6600 v., 60 cycles and stepped down to 460 v., 3 phase for distribution through the factory. An average monthly bill shows a consumption of 327,300 kw-hr. at an average power factor of 68 per cent. The chart on the demand meter shows wide fluctuations in load, varying during the day from a low of 75 kw. up to a momentary peak of 1250 kw. A little study, however, reveals that an average load can be estimated for each of three working shifts and that departure from these averages are not very great

Table I. Effect of Capacitor on Induction Motor Load

25 Hp—3 Phase—60 Cycles—4 Pole—440 Volts						
% Loaded	0	25	50	75	100	125
R-Kv-a.	8.7	8.6	9.1	10.3	11.2	13.7
% P.F.	12.3	56	76	84	87.5	89
With 5 Kv-a. Capacitor						
R-Kv-a.	3.7	3.6	4.1	5.3	6.2	8.7
% P.F.	28	85	94	95	96	95
With 10 Kv-a. Capacitator						
R-Kv-a.	*1.3	*1.4	*.9	.3	1.2	3.7
% P.F	*64	*97	*99.6	99.98	99.8	99

*Leading.

from one month to the next. These load conditions are as follows

a. Week-end conditions exist 240 hr. per mo. during which the average demand is 64 kw. at 50 per cent power factor.
b. Night shift operates 168 hr. per mo. with an average demand of 260 kw. at 76 per cent power factor.
c. Evening shift operates 168 hr. per mo. with an average demand of 640 kv. and 70 per cent power factor.
d. Day shift operates 168 hr. per mo. with 960 kw. average demand and 67 per cent power factor.

By checking over the power bills it is found that a good savings is possible by correcting to 95 per cent power factor. With an energy consumption of 327,300 kw-hr. and 68 per cent power factor, the reactive kv-a.-hr. are 351,900. For an average power factor of 95 per cent and the same kw-hr. consumption, the reactive kv-a.-hr. must be reduced to 108,000. This is figured from the formula

$$PF = \frac{\text{Kw-hr.}}{\sqrt{\text{Kw-hr.}^2 + \text{R-kv-a.-hr.}^2}}$$

Or the same result may be obtained quickly from the curves in Fig. 1, which shows the reactive kv-a. for each kw. over a range of power factors.

Referring to the load analysis, it is at once evident that the week-end load is the lowest point to which the load drops and that if a capacitor is selected to correct this to 100 per cent power factor, this capacitor can remain connected to the circuit at all times. The average demand of 64 kv-a. at 50 per cent power factor is shown by Fig. 1 to have an average reactive kv-a. demand of 110. A capacitor of 110 kv-a. rating set aside for this purpose and connected continuously will subtract 740 hr. $\times$ 110 = 81,400 reactive kv-a.-hr. per mo. from the total of 351,900. Consider now the night load of 260 kw. average demand and 76 per cent power factor. This load is the lowest average incurred at any time during the working week. A capacitor of 220 kv-a. will entirely cancel out the reactive kv-a. of this load. Since 110 kv-a. of capacitor has already been applied to operate continuously, only 110 kv-a. more need be added to have the required value of 220 kv-a. Because this is the minimum average load at any time during the week, this 110 kv-a. capacitor can remain connected except during the week-end, or operated 504 hr. per mo. Used in this way, the capacitor will produce a further reduction of 504 hr. or 110 kv-a. or 55,440 reactive kv-a. hr.

If the 640 kv-a. average demand occurring with the evening shift is considered in the same way, a capacitor requirement of 330 kv-a. in addition to the 220 now connected is obtained. This 330 kv-a. connected for 336 hr. per mo., or during the day and evening shifts, produces 108,000 reactive kv-a. The reactive kv-a. hr. per mo. of these three capacitors adds up to 244,840 reactive kv-a. hr., leaving an uncorrected reactive load of 107,060 reactive kv-a. hr., which makes the average power factor 95 per cent. Table II shows this solution in tabulated form.

By reducing the power factor improvement problem to terms of reactive kv-a. hr., and recognizing the wide range in capacitor rating that will show the wanted result, estimating the capacitor requirements becomes comparatively easy. The actual selection of the capacitor ratings is hardly more difficult that the choosing of an adequate transformer to supply a given load or the proper motor for a particular drive.

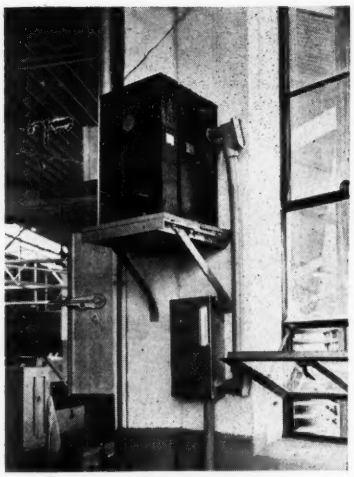


Fig. 3. A small capacitor installation in a factory

Table II. Power Factor Improvement Analysis

PRESENT—
Energy consumed ..... 327,300 Kw-hr. per mo.
Reactive energy used..... 351,900 R-Kv-a.-hr. per mo.
Power factor 68%

DESIRED—
Energy consumed ..... 327,300 Kw-hr. per mo.
Reactive energy used..... 107,000 R-Kv-a.-hr. per mo.
Power factor 95%

LOAD CONDITIONS—	LOAD				CAPACITATOR		
Shift	Hr. per Mo.	Ave. Kw.	Ave. R-Kv-a.	Ave. P.F.	Kv-a.	Hr. per Mo.	R-Kv-a. per Mo.
Week-end	240	64	110	50	110	740	81,400
Night....	168	260	220	76	110	504	55,440
Evening.	168	640	650	70	330	336	108,000
Day	168	960	1060	67			
TOTAL.....					550		244,840

Total plant R-Kv-a. hr. 351,900
Total capacitor R-Kv-a. hr. 244,840
Total R-Kv-a. hr. required from Power Company..... 107,060

Ammonia Fertilizer

In the west where crops are crops, they've been growing even bigger and better lately with gaseous ammonia blown into irrigation water according to the A.P.I.

Gaseous ammonia in its raw state is a petroleum gas, a mixture of methane, ethans, nitrogen, oxygen and several other things.

The gas is cracked and unwanted substances are removed. Cracking produces carbon, which is washed out with water and removed by electrical precipitation.

This is only the beginning. Before ammonia is obtained, the hydrogen must be purified. This is done by putting it through iron oxide boxes, an oil scrubber, a water scrubber, and two caustic soda scrubbers. Then it is ready for the final process of purification. This involves cooling the gas to minus 380 deg. F., after which the gas is washed through liquid nitrogen obtained from the air. The scene then changes to the synthesis plant where the gas loses the last of its oxygen and carbon monoxide and is synthesized into ammonia which emerges as a gas, ready for liquefaction or crystallization.

The PRACTICAL ENGINEER and ELECTRICIAN

RALPH E. TURNER, EDITOR

MR. KRAMER TAKES OVER

When this section of Power Plant Engineering was started a year and a half ago, the pattern was set by Andrew W. Kramer, Electrical Editor of the staff. Every expectation as to the acceptance by readers of the Practical Engineer and Electrician has been realized, so with this issue off the press, the management of the department goes back to Mr. Kramer. Since last January you readers have had an opportunity to get better acquainted with Richard H. Morris, Engineering Editor, who so splendidly put his personality into these pages from January to June and left an accumulation of data and articles which have formed a considerable portion of the material used during the past half year. And we are certain that the idea of rotating the responsibility has been helpful all the way around. On this shift, however, Mr. Kramer will take over for the entire year as the longer swing seems to be needed to carry out formulated plans.

In the course of his editorial work during the past year, Mr. Kramer has been to both the east and west coasts, and has visited many power plants and engineers, attended technical meetings and important conferences with leaders in the field. The information he has gathered and opinions formed are being made available to readers through these pages and supplementary correspondence. I am sure you will again enjoy this contact with him.

R. E. T.

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WHEN NEEDING A NEW CHIEF

Management may place faith in a certain successful outsider. Or perhaps choose an engineer of varied experience, again from the outside. But what about the possibilities among the men within the plant?

By Frank V. Faulhaber

THE TEMPTATION IS INVITING

PERPLEXING and worrisome, indeed, is the situation when a new engineer, capable and competent, must be found to assume charge of the staff. This is particularly true when the management repeatedly has experimented with different individuals, yet never to the desired degree of success. For one or more reasons the chief engineer simply did not fit in with plans, so the management continues to grope, experiment and hope, more or less disappointedly. So many times the entire plant is put out of joint because of the lack of a proficient chief engineer. Admittedly it is no snap to pick forthwith an individual with desirable qualifications and experience befitting requirements. Frequently someone is invested with top power plant responsibility, in whom the management has not complete faith, simply because a better man cannot be obtained. Sometimes it is trusted, at any rate, that things eventually will turn out all right. And yet, in due course, it develops that the engineer chosen is simply not the desired one. So, once again, the plant executives reach out and pick, speculatively and hopefully.

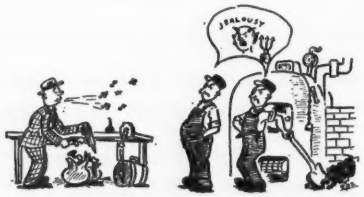
One-Plant Successful Engineer

Now where will the executives turn to find this right engineer? Will they try to lure away from some other plant a certain engineer who has attested specific ability, ambition and accomplishment? The temptation, to be sure, is inviting. There is a consultation, discussion aplenty, considerable pondering, many pros and cons cropping up. Finally it is decided to make overtures to some engineer who has proved, in another plant, to be competent to secure results.

Initially the management hits a snag. It was agreed to offer a certain salary which the management did not care to exceed. This successful engineer, naturally, does not care to relinquish his present position, where he is assured undisturbed authority and where he is considered a rock-seated fixture. He represents a respectable figure where he now holds sway, and certainly he is not readily extracted in favor of some position of more or less uncertainty and dubiety. Sometimes, however, an attractive inducement will work the trick. The harassed plant management, driven to wits' ends and impelled to do almost anything, finally decides to bend over a little—a generous financial gesture is exhibited, and, at last, the sought engineer agrees to take charge.

There is a new "chief" on the way, now. This engineer, mind you, comes with feather in cap, figuratively, for he certainly has shown results. Smooth sailing, however, does not always result and things, somehow, develop at variance with plans. Here you have a veritable newcomer. True, he has proved successful—however, in that other plant. This new chief may be one of those old-timers, most of his experience perhaps having been gained in but one plant. If that is so, then he is all the more likely to be a set-idea man; he has his own preferred way of doing things, and likely he is not readily receptive to others' well-meant ideas and suggestions. So, at the very outset, the prospects of power-plant coöperation are not very promising.

So many times the engineer of set ideas and opinions views unfavorably the new. He leans toward old methods that for him have proved effective, even though these methods may now be out of date and out of place in another plant where conditions may call for an entirely different set-up or procedure of management. It must not be overlooked, either, that the old-time engineer, notwithstanding all his peculiar experience, may find himself in very strange and unfamiliar surroundings when he undertakes responsibilities in another power plant. Here, in this other plant, there are other problems, many new and unfamiliar. Different troubles must be met and mastered. Oftentimes there is different plant equipment, different materials, different plant operation, different conditions all around. Too, there is a different engineering staff; this in itself presents a perplexing, oftentimes vexing problem. It cannot lightly be gainsaid that this new chief is not likely to find things running as smoothly as he would wish. The staff under him comprises men of varying temperaments, abilities and ambitions. As a whole, it may not take readily to his authority, frequently assumed as arrogant, thoughtless and domineering. And how can he win coöperation when he is unreasonable and himself unreceptive to their suggestions?



OUT AND UP FROM YOUR PLANT

Sometimes entailed is a definite and sizable contract before a certain engineer can be drawn away from another plant. The engineer, assuredly, is not going to enter some seeming gamble, and he insists on assurance of satisfying employment. Why should he take the chance of being dismissed, summarily? For this he cannot be condemned. Hence, when the management has entered into a contract with such an engineer, and developments prove unsatisfactory, the plant, sequentially, finds itself face to face with a very disconcerting problem: the management has on its hands a man who cannot be easily and briefly dismissed, and its engineering perplexities indeed will not be looked upon with envy.

Outside Engineer With Varied Experience

But, let us now turn to the engineer of varied experience, obtained under various conditions in different power plants, mayhap in different cities. Here you have

a man of wider experience—no narrow, limited individual, he. More likely is he to understand and appreciate requirements of different plants. In each power plant we find different machinery, equipment and materials, though much of it may be of similar character. Operations may be of a different kind. There may be a different plant schedule by reason of the particular product manufactured. There is an entirely different organization, an entirely different management, in each place. And always we must keep in mind the fact that in each power plant we will find a different engineering staff, representing varying temperaments, proficiency, ambitions, foibles—a veritable problem, not always welcomed, and an individual one, in each case. Conditions, as can easily be sensed, are individual in each instance; methods effective for one power plant will not necessarily prove equally effective for another. That is one reason why an engineer of attested success in another plant so frequently proves a complete and dismal flop elsewhere.

Another picture is presented, however, by the engineer who has observed engineering conditions and operations in varied plants. Firstly, he is the more certain to welcome suggestions. He comes not with narrow, limited focus. He appreciates better the value of coöperation, as a rule, knowing that each power plant presents an individual problem with individual requirements. Set, rigid methods will not do, and he is likely to be more amenable and more willing to listen to reason. Nor, in his case, is there likely to be involved a staggering salary temptation, as in the case of the deep-rooted engineer whose reputation may be based mainly on the results achieved in *one* power plant. That is an angle well worth pondering.

Staff-Developed Engineer

And now we come to your own power plant. In all likelihood, there is now among your own staff some individual with peculiarly favorable and promising abilities, of attested experience and ambition. May he not be deserving of promotion to "chief"? Is he not worthy of recognition and development? Cannot this man be chosen and coached for the position that has presented a difficult problem—a problem with which one may have had to cope too many times, with considerable harassment and discouragement, and never successfully?

So many times are promising individuals, right in your own power plant, finally lost to some other plant where the management snaps up an opportunity, to use these ambitious individuals for their own interests and progress, subsequently developing these men, to all-around benefit and gain. In each power plant there are deserving individuals desirous of promotion and recognition. How, in your own plant, can enthusiasm, loyalty and plant growth be generated and fostered more than by encouragement and opportunity to worthy individuals? How many times has some promising man, for no apparent reason, left his position, subsequently resulting in considerable loss to your own plant? Maybe it has been the plant's policy too many times to bring in rank outsiders, resulting later also in plant dissension and discord.

So many times there are possibilities resident right within your own plant. It is all well and good to keep a watchful eye on outside sources for likely engineering material, but we must not miss potentialities existent in our own plant. We must not neglect the matter of individual and power-plant development. We must not be so tempted to turn to other fields, meanwhile neglecting one's own power plant. An engineer selected from your own staff is more likely to know what is required and expected than some outsider; he is likely to understand better the peculiar conditions and problems of your own power plant. He has been employed there for some time. The longer he has worked for you, the better you should know him. This man is already a part of your power plant, do not forget that! He knows the plant's machinery, the equipment, the materials in use, the procedures in practice and preferred, the methods most favorable. He knows the staff; he understands the plant's objects and policy. Is this not the individual with whom you can best work and coöperate? How many times would the staff much rather work with and for an engineer chosen from its own ranks? There is manifest opposition to some utter outsider, particularly when he comes with stiff arrogance and a manner wholly unreasonable. The individual chosen from one's own ranks for the position of "chief" is certain, moreover, to be more willing to work amicably with the management. His retention in his new position can be governed upon results, what he knows, what he shows, and, bear in mind, what he has already shown *in your own plant!* Most importantly, it is not a question so much of what a man has done in another plant as what can he do in *your own power plant?*

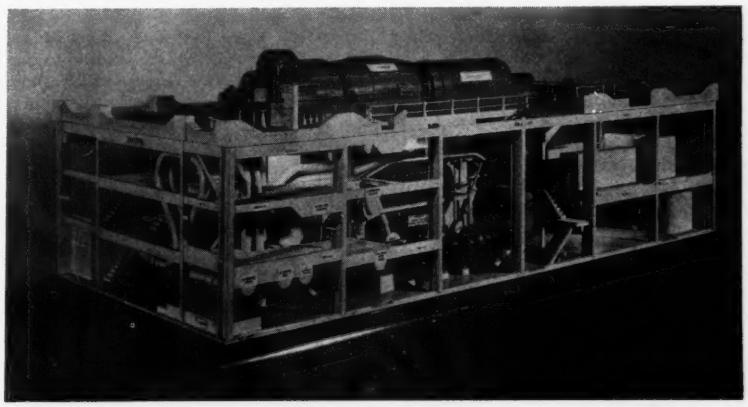
There is also the comforting factor represented in the financial phase. In selecting someone from your own forces as "chief" there is not entailed the risk and high salary as applies when an outsider must veritably be extracted from some other plant. Your own staff-man, to be sure, is no complete stranger in your own plant. He is not, as is so many times the outsider, albeit reputedly successful elsewhere, so completely at sea, blindly groping about, unsure of himself. He has his bearings, and knows what is wanted. When next the necessity for appointment of a new "chief" crops up, consider and test potentialities within your own power plant, and when opportunities there are exhausted, there is still chance aplenty to experiment with the outsiders.

It Pays To Listen

By G. L. Radamaker

MANY young engineers are afflicted with what psychologists refer to as "delusions of grandeur", in regard to the knowledge that they believe they possess about practical operating engineering. These young engineers, who have been "exposed" to several years of grammar school, high school, and perhaps even college have the attitude that many of the older men in the power plant are archaic and out of date.

After they have spent several years in and around power plants, they realize that the old timers aren't as ignorant about practical engineering as they thought at first. But it is the beginner with just sufficient training in engineering to make a fool of himself who should be the first to listen when the older engineers speak.



Bank Shows Model Power Plant in Lobby

West Allis, that growing industrial suburb adjoining the city of Milwaukee to the southwest, is the home of the Milwaukee County Bank, which uses space in its lobby for the showing of products made in the city. As is well known, one of the principal industries of Wisconsin, the Allis-Chalmers Manufacturing Co., is located in this suburb (in fact, the community was named after the company giving employment to so many of the citizens). In the picture is a model of the Port Washington power plant of the Wisconsin Electric Power Co. which recently occupied the bank's lobby space. This model was donated for the occasion by Allis-Chalmers, as the turbines and other machinery in the plant were made by this firm.

I remember a few years ago when I first started in the trade or profession of operating engineering, that I learned that it pays to listen. One old timer was assigned the difficult task of breaking me in and to try to make me understand what made the power plant go. Since he hadn't studied calculus, alternating current phenomena, and thermodynamics, I felt that he wasn't very well informed and that I would probably end by teaching him plenty about the station.

One day he made the statement that he had used potato peelings in the treatment of boiler water, this kind of stuck in my throat. I thought, "What does this old coot take me for?" I had heard all about left handed monkey wrenches and I figured this was another practical joke in the same class. I didn't say anything at the time but I thought plenty.

Some time later I happened across a technical engineering book telling about the use of organic chemicals in the treatment of boiler feedwater, one particular chemical was mentioned and also in this technical article it stated that this chemical which was very efficient was formerly obtained from (no fooling) potato peelings.

When I read this, the old timer went way up in my estimation and from then on he got as much of my respect as a college professor. From then on when he spoke I listened, and learned plenty. One of the main facts that I did learn was that all information is not in books. You can't learn from a book, how to get the "feel" of a machine or power plant, but an old timer with plenty of experience in the operation of power stations can tell you.

FOR THE PLANT ELECTRICIAN

Wiring for Economy

FEW PEOPLE, even engineers who have calculated voltage drop on a loaded circuit, have a mental picture of just what this drop means to the efficiency of a lighting system. Incandescent lamps are very sensitive to voltage changes and manufacturers have developed lamps to the point where they are most economical when operated at their rated voltage. A change of 1 per cent in voltage delivered to an incandescent lamp changes its output about 3 per cent while a 5 per cent voltage drop gives a 16 per cent decrease in light. Fluorescent lamps are not so sensitive to voltage changes as are those of the incandescent type. Voltage drops of 10 to 15 per cent below design rating of mercury lamps will cause them to be extinguished.

All this points to the importance of having the lighting system wiring of sufficient size to carry the load without a voltage drop detrimental to lamp efficiency. For many years in the past electricians used No. 14 wire as more or less of a standard for all branch circuits of lighting systems. Wire of this size will carry 15 amp. safely but there will be a 2 v. drop in only 25 ft., and circuit of over 100 ft. are not uncommon.

Modern practice in industrial service is to limit each 15-amp., 115-v. circuit to an initial load of not more than 1000 watts, to use no wire smaller than No. 12, or, in certain cases, No. 10, and to allow no branch run to exceed 100 ft. to the first outlet. Good practice for heavy-duty lamp circuits limits the load per circuit at 1500 watts for No. 10 wire, 2500 watts for No. 8 wire and 3000 watts for No. 6 wire.

In order to visualize the voltage drop in a branch circuit, A. K. Gaetjens, of the Nela Park Engineering Department of the General Electric Co., employs a scaled board in front of which a cable is supported by springs, lamps are represented by weights that are hung at various points along the cable. This device, as will be noted by the accompanying illustrations, draws curves which show clearly what happens when various parts of the circuit are loaded, and gives a picture readily fixed in the mind. The accompanying table of wire sizes has been computed as a guide for use in designing lighting circuits.

Many factories are now finding it necessary to extend their circuits, load them heavier, or, in some cases, rewire their buildings, and engineers can save their companies money and improve light-

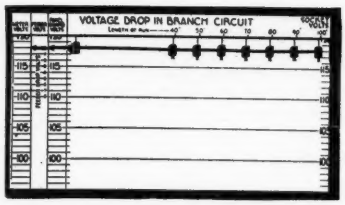


Fig. 1. At no load there is no voltage drop between the meter and the light socket

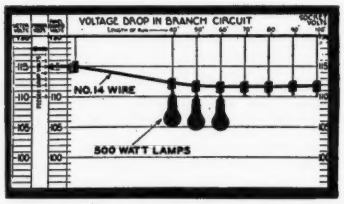


Fig. 2. Loading a No. 14 wire with 1500 watts at 50 ft. from panel board drops the voltage from 118 at the meter to 112 at the lamps

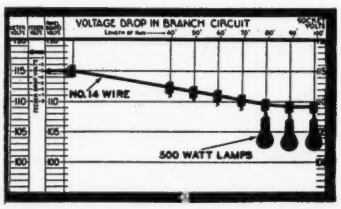


Fig. 3. At 90 ft. from the panel and No. 14 wire a 1500-watt load reduced voltage to 109

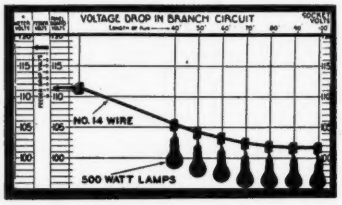


Fig. 4. Heavily overloaded circuits give inefficient lighting and high unit lighting cost

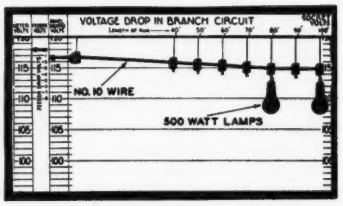


Fig. 5. No. 10 wire is recommended for runs between 50 and 100 ft. where the initial load is 1000 watts per circuit

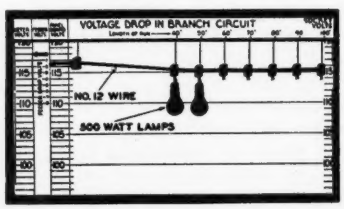


Fig. 6. Initial loads should not exceed 1000 watts on No. 12 wire for runs up to 50 ft.

Size of wire required for a maximum of 2 v. drop on 2-wire, 120-v. circuits

Length of Run (Panel Box to Load Center) (Feet)	Watts per Circuit									
	500	600	700	800	1000	1200	1400	1600	1800	2000
30	..	..	..	..	..	..	..	12	12	12
40	..	..	..	..	..	12	12	12	10	10
50	..	..	..	..	12	12	10	10	10	10
60	..	..	..	12	12	10	10	10	10	8
70	..	..	12	12	10	10	10	8	8	8
80	..	12	12	12	10	10	8	8	8	8
90	12	12	12	10	10	10	8	8	8	6
100	12	12	10	10	10	8	8	8	6	6

ing conditions by proper selection of wire sizes and by keeping branch circuits short. With continuously growing uses of electricity, and particularly the increasing recognition of the need for greater light intensity properly distributed, new wiring jobs should always be designed for probable increase in electrical requirements. More wiring capacity than required for present needs will nearly always be found to be an economical investment for line losses take place whenever current flows and the larger the wires the less will be the losses. It is estimated that the wiring capacity can be doubled for about one-third increase in cost.

Those faced with a rewiring job will be benefited by a change made in 1931 in the National Electric Code which permits an increase in the capacity of the widely used ½-in. conduit. In the former code the specifications was for 2 or 3 No. 14 wires or 2 No. 12 wires, now it permits 3 No. 12 wires. This change makes possible the installation of a 230-115-v. 3-wire common neutral branch circuit, replacing any previously allowed circuit and at least doubling the capacity of any 2-wire circuit which it may replace, and the cost is low compared to many rewiring installations.

Induction Method of Surface Hardening

One of the uses to which electricity has been put in industry is that of localized surface hardening. This job requires that the grade of steel used will respond to rapid heating to the critical temperature, then quenching. It is reported by the Ohio Crankshaft Co. that processes have been developed whereby standard S.A.E. steels as well as various cast materials can be surface hardened by inductive heating methods.

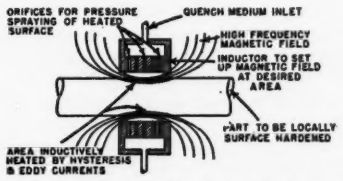

ORIFICES FOR PRESSURE SPRAYING OF HEATED SURFACE
QUENCH MEDIUM INLET
HIGH FREQUENCY MAGNETIC FIELD
INDUCTOR TO SET UP MAGNETIC FIELD AT DESIRED AREA
PART TO BE LOCALLY SURFACE HARDENED
AREA INDUCTIVELY HEATED BY HYSTERESIS & EDDY CURRENTS

Diagram of Surface Hardening Equipment

In this process, the part to be locally surface hardened, such as a shaft, is placed within a wound coil or inductor carrying sufficient alternating current to heat that portion of the shaft which is within the magnetic field of the inductor. By using sufficient power it requires only a few seconds to bring the surface zone up to the critical temperature.

At the exact instant necessary, quenching of the heated zone is provided by pressure jets of cooling liquid ejected through orifices that are integral with the inductor block. This permits quenching without air cooling. The diagram illustrates the arrangement of equipment. A variety of inductor shapes are available by means of which forms and shapes can be treated through the control of magnetic flux and accurate tuning.

Shutdown Prevented by Electric Welding

One of the country's large public utility companies not long ago averted a possible forced shutdown with its accompanying financial loss and the cost of entirely new boiler smoke stacks by a welding repair job.

Engineers upon inspecting two of the company's three 75-ft., 20-yr. old steel stacks found that the ⅜ in. thick steel center plates had been corroded down to as little as 1/64 in.; in some places found a full ¼ in. of rust. The corrosive action of combustion products was given as the cause.

To solve the problem of supporting the top half of the stack so that the corroded plates could be removed, the Weldrite Corp., which was employed to do the job, used offset steel angles welded across the faulty section. The old plates were cut out, leaving the stack's upper portion supported only by the angles. It is believed this is the first time such a method of support has ever been employed for a welding job of this kind.

Welders with new steel plates then were put to work. They welded in place on each stack eight, 9 ft. by 4 ft. by ⅜ in. new plates. Three inch vertical overlaps were employed at the junctures of the old and new steel.

During the time the center section plates were out, the boilers were shut down, but before completion of the welding, they had been re-fired. Had a new brick chimney been built, or new steel stacks provided, the boilers would necessarily have had to shut down completely while the breeching was being installed or stacks were erected.

Fig. 1. Corroded plate from steel stack being lowered to the ground after its removal by flame cutting

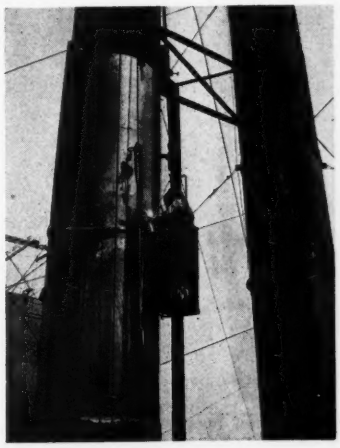


Fig. 2. Workman welding new center section plates on stack using a 200-amp. Westinghouse FlexArc welder

FUEL ENGINEERING

Coal Selection Procedure

As fuel is the most important raw material used in the operation of steam power plants, every precaution should be taken to make sure that it fits in properly with the needs of the individual plant. American industry has an annual fuel bill of more than $600,000,000 which is distributed among nearly 100,000 industrial plants. The principal source of this fuel is 6000 coal mines operating in 200 seams, each of which yields a product with individual characteristics, physical as well as chemical. To these natural characteristics, commercial requirements demand such refinements as sizing in as many as thirty grades, washing, and treatments to allay dust.

Coal selection thus becomes an extremely complicated problem, a correct solution of which is vital to the economical operation of a plant. First of all, the coal selected must be able to meet the load demands with equipment installed, which also implies that in seasons of low load it is sometimes economical to use a lower priced coal than when the burning equipment must be forced to the limit of its capacity.

The second requirement is that of economy which is a problem that cannot be completely solved without tests and recorded operating data. Many engineers have found that certain fuels meet the load requirement most satisfactorily but at a cost much higher than with another coal which requires more careful attention in burning.

Industrial centers where most power plants are located are usually heavily populated and in these districts the third requirement, that of a minimum of nuisance, becomes paramount. Smoke, fly ash and dust dictate, in many cases, not only the choice of coal but the type of burning equipment.

Continuity and reliability of supply comes fourth in the list of requirements. In this connection, the engineer must consider the reliability of the coal operating company, coal reserve and fa-

cilities for preparation, mining conditions, transportation facilities, and other factors contributing to continuous and uninterrupted supply.

With these general requisits in mind, A. W. Thorson, assistant fuel service engineer of the Chesapeake and Ohio Railway Co., outlined before the Joint Fuel Conference of the Coal Utilization Institute and Appalachian Coals, Inc., at Ann Arbor, the procedure he employs in the selection of coal. Briefly his method is as follows:

1. Survey the coal market. Secure analytical data, quotations of mine prices and transportation charges to the plant. Be sure to include in the list all coals which have a remote chance of competing. Compile an orderly list of chemical and physical properties, delivered prices and approximate costs in cents per million B.t.u. or other common denominator.

2. Survey the plant. Locate all possible limitations to coal selection; determine the maximum combustion rates of the burning equipment, and the limits of ash softening temperature that can be tolerated. If pulverizer fired, determine mill capacities and corresponding grindability factor. Check coal handling equipment and bunker size for possible restrictions. Determine if setting heights are sufficient for smokeless operation. In short, comb the plant for any conditions which may affect the choice of coal, being assured finally that any limitations are real and not assumed.

3. Eliminate from the list those coals that cannot meet the load requirements and plant limitations.

4. Secure complete data on the cost and performance of the present coal. In other words, find out what the plant is doing with its present coal before attempting to find out what it will do with other coals.

5. Using the information obtained under No. 4, estimate the cost and performance of competing coals, using the information available in the literature, supplemented by good judgment. In this way the performance and cost of other coals can be approximated, thereby furnishing an excellent basis on which to judge their potentialities.

6. Eliminate from the remaining list those coals which appear to be least economical or completely out of the picture.

7. Test carefully and completely those remaining coals which now appear to meet load requirements and produce economical results.

8. Check test results with the estimates to verify their accuracy, revising all estimates if necessary. Such revision may reinstate certain coals previously eliminated.

To further clarify this procedure by means of an example, Mr. Thorson assumed an industrial plant burning pulverized coal in dry bottom furnaces, that the installed pulverizer and boiler capacity is sufficient for all competitive coals. Table I shows a list of all coals appearing to be competitive. The various properties relative to plant adaptability are tabulated together with the price data. Notice particularly that the hydrogen content is included.

Table II shows the calculated combustion losses which vary with a change in coal supply. The stack loss and hydrogen loss are, of course, the major items. The relative efficiency, obtained by difference, is higher than will be shown by evaporation test but the figures are relatively correct and sufficiently accurate for the purpose. Note that the heating value of the various coals ranges from 12,700 to 14,400 but the portion recoverable in the heat conversion process ranges from 10,300 to 12,400. The coal prices and relative efficiency data are used to compute the unit coal cost on Table III. The other plant cost items which vary with coal supply are estimated and tabulated, to arrive at the total cost of variable expense in cents per thousand pounds of steam generated. Assume that the plant is now operating on Coal A, and that the actual evaporation and costs are known. The costs for the other coals are arrived at by judgment and use of data in the literature showing the effect of coal properties upon these various items. Assuming that we can afford to pay $3.85 per ton of Coal A, the table shows what can be paid for the other coals, by the adjustment of each coal price to a steam cost of 22.1 cents per thousand pounds, that obtained with Coal A. Comparing what we can afford to pay with the quoted prices, we arrive at a gain or loss for each coal. These vary from plus 21 cents per ton for Coal C to minus 24 cents per ton for Coal B. In other words, based on the estimates, Coal C is the most economical, Coal B the least economical in the group.

You will note that the price in dollars per ton, in cents per million B.t.u. and the unit coal cost in cents per thousand pounds of steam all fall in the same order.

TABLE I. TYPICAL COAL ANALYSES
1¼ x 0 Size

COAL	A	B	C	D	E	F	G	H
Moisture, as fired %	4.8	5.5	6.0	4.5	3.8	4.2	4.1	3.8
Volatile, as fired %	34.5	38.8	33.4	32.2	35.0	31.4	25.0	21.0
Fixed carbon, as fired %	54.7	48.1	53.6	54.8	54.6	58.9	67.0	70.2
Ash, as fired %	6.0	7.6	7.0	8.5	6.6	5.5	3.9	5.0
Sulphur, as fired %	0.8	3.0	1.2	1.1	0.9	0.9	0.4	0.5
Hydrogen, as fired %	5.5	5.1	5.3	5.0	5.0	5.5	5.0	4.6
Heating Value, as fired B.t.u. per lb.	13,300	12,700	13,200	13,200	13,500	13,900	14,400	14,400
Ash Softening Temp. Minimum, deg. F.	2450	2100	2400	2400	2200	2700	2500	2300
Grindability, Hardgrove	50	57	60	64	56	70	100	103
Coal Price $/per ton delivered	3.85	3.55	3.55	3.65	3.80	4.05	4.40	4.40
Coal Price cts./per million B.t.u. delivered	14.5	14.0	13.5	13.8	14.1	14.6	15.3	15.3

TABLE II. COMBUSTION LOSSES
Industrial Plant Burning Coal A in Pulverized Form in Dry Bottom Furnaces
Pulverizer and Boiler Capacity Sufficient for All Coals Compared

COAL	A	B	C	D	E	F	G	H
1. Stack loss, % of coal	8.4	10.6	8.5	8.5	8.9	8.4	8.0	8.4
2. Moisture and Ash loss, % of coal	2.5	3.1	2.9	3.3	2.6	2.3	1.7	2.1
3. Unburned Carbon loss, % of coal	0.6	0.4	0.6	0.9	0.4	0.5	0.3	0.5
Hydrogen loss, % of coal	4.5	4.4	4.3	4.1	4.0	4.3	3.7	3.5
4. Banking loss, % of coal	...	0.1	...	...	0.1	...	...	...
Total losses, % of coal	16.0	18.6	16.3	16.8	16.0	15.5	13.7	14.5
Relative Efficiency % (by diff.)	84.0	81.4	83.7	83.2	84.0	84.5	86.3	85.5
HEATING VALUE OF COAL								
B.t.u. per lb. as fired	13,300	12,700	13,200	13,200	13,500	13,900	14,400	14,400
B.t.u. per lb. recoverable	11,180	10,330	11,050	10,970	11,320	11,720	12,420	12,300

1. Assumed to vary with excess air, which must be sufficient to keep temperature of gases entering boiler tubes equal to the ash softening temperature of coal; and with stack gas temperature, which must be above dew point for sulphur content of gases.
2. Allowance of 0.1 per cent for each per cent of moisture, and 0.33 per cent for each per cent of ash.
3. Assumed to increase in proportion to decreasing excess air, volatile matter and ash content.
4. Assumed that for ash softening temperatures below 2300 deg. F. extra boiler must be carried during day loads to prevent excessive tube slagging.

TABLE III. COMPARATIVE OPERATING COSTS
Based on Tests and Costs Obtained on Coal A

COAL	A	B	C	D	E	F	G	H
Coal Price, $ per ton delivered	3.85	3.55	3.55	3.65	3.80	4.05	4.40	4.40
Coal Price, cents per million B.t.u. delivered	14.5	14.0	13.5	13.8	14.1	14.6	15.3	15.3
1. Coal Required, lb. per 1000 lb. steam	101.3	109.7	102.5	103.2	100.2	96.6	91.2	92.2
Coal Cost, cents per 1000 lb. steam	19.5	19.5	18.2	18.9	19.1	19.5	20.0	20.3
Coal Handling, cts. per 1000 lb. steam	0.8	0.9	0.8	0.8	0.8	0.7	0.7	0.7
2. Coal Preparation, cts. per 1000 lb. steam	0.5	1.2	0.6	0.6	0.6	0.5	0.3	0.3
Ash Disposal, cts. per 1000 lb. steam	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Boiler Operation, cts. per 1000 lb. steam	0.7	0.9	0.7	0.7	0.7	0.7	0.6	0.7
Boiler Room Maintenance, cts. per 1000 lb. steam	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4
Total Cost Variable Expense cents per 1000 lb. steam	22.1	23.4	21.0	21.7	21.8	22.0	22.2	22.6
Can afford to pay, $ per ton delivered	3.85	3.31	3.76	3.73	3.86	4.07	4.38	4.28
Gain or Loss on Quoted Price cents per ton	...	24	21	8	6	2	2	12

1. Coal Required $= \frac{1000}{\text{Actual Evaporation of Coal A} = 9.9 \text{ lb./lb.}} \times \frac{\text{B.t.u./lb. recoverable — Coal A}}{\text{B.t.u./lb. recoverable — other Coals}}$
2. Includes power which varies with moisture content, fineness and grindability; and maintenance which varies with volatile matter, ash and sulphur content.

None of these, however, furnishes a true comparison of value until the total cost of all variable factors is found. Notice that Coal G, one of the most expensive in dollars per ton, shows a lower total cost than Coal B, one of the least expensive in dollars per ton. The gain or loss figures are of course based on a quoted price of $3.85 for Coal A. If this price increases only 2 cents per ton, or the price of Coal G decreases only 2 cents, the two are on a par.

Luminous Flame Firing

By J. R. Darnell

THE INQUIRY by P. J. F. in the May issue, page 87, was quite correctly answered by R. C. Vroom who pointed out the advantages of non-luminous flame firing over any that might be had with the luminous flame. Zuce Kogan in the August issue, page 78, criticizes Mr. Vroom and ends his dissertation by advising P. J. F. to use a luminous flame because "he will definitely get more capacity with the luminous flame than could be had from the non-luminous flame because more heat will be absorbed from the luminous flame as radiant heat."

If Mr. Kogan means total heat absorbed by the boiler, he is entirely mistaken. Mr. Vroom pointed out "that if two flames have the same shape, and are at the same temperature, a luminous flame will have a greater emissivity and will radiate at a higher rate than a non-luminous flame."

But when burning the same kind of gas in the same furnace, as P. J. F. proposed, if the flame is made luminous it will not be at the same temperature, and therefore, even if the heat output from the flame as radiation is greater, the total heat absorbed by the boiler will be less.

Mr. Vroom pointed out that any increase in radiation due to luminosity is more than overbalanced by the lower flame temperature and since heat transmission by radiation is a function of the fourth power of the absolute temperature difference between the source of radiation and the heat absorbing surface, a small change in flame temperature has a marked effect on the rate of heat transfer by radiation.

It should be observed that unless all the facts are known, a little knowledge is a dangerous thing. No less authority than Haslam and Russell in their book "Fuels and Their Combustion" at page 279, state:

"In luminous flames, as was intimated above, in addition to the radiation due to chemical reaction (electronic rearrangement), common to both luminous and non-luminous flames, there is also the radiation from the incandescent carbon particles which have been deposited in the flame by cracking. The generally accepted theory is that the carbon particles act as carriers or forwarders of the heat. These tiny bits of carbon, deposited in the flame by cracking, are instantly heated by the hot gases of the flame to a state of incandescence, in which condition they radiate heat to the cooler surroundings, exactly the same as would a solid body. While in non-luminous flames experimental results seem to indicate that the radiation is to a large extent independent of the temperature, a consideration of the above statement shows that this is obviously not true for that part of the radiation from the luminous flame which is due to the carbon particles, for if the radiation from the carbon particles is the same as that from solid bodies, which there is every reason to believe is the case, then the radiation from the carbon particles will follow the Stefan-Boltzman law, and will be a function of the fourth power of the absolute temperature of the flame."

Mr. Kogan may have gotten an increased capacity for an industrial furnace by using a luminous flame, but not for the reasons that he states he did. Haslam and Russell, and also Mr. Vroom, call attention to the size and shape of the flame as an important factor. Perhaps Mr. Kogan got a better heat distribution with the luminous flame because the material being heated was a solid and could not circulate past the source of heat as in the case of water in a boiler. When heating forgings an even distribution of heat all around or over the material is more important than a higher temperature of the flame where such flame is concentrated more or less at one point. There may be other factors which Mr. Kogan hasn't mentioned.

Mr. Vroom very wisely anticipated the very thing which Mr Kogan thinks justifies his position. Mr. Vroom said:

"Anyone who had had a good deal of experience with metallurgical furnaces might thus easily fall into the error of assuming that the use of some such method of fuel-air mixture to produce a luminous flame would be equally advantageous in the case of firing boilers."

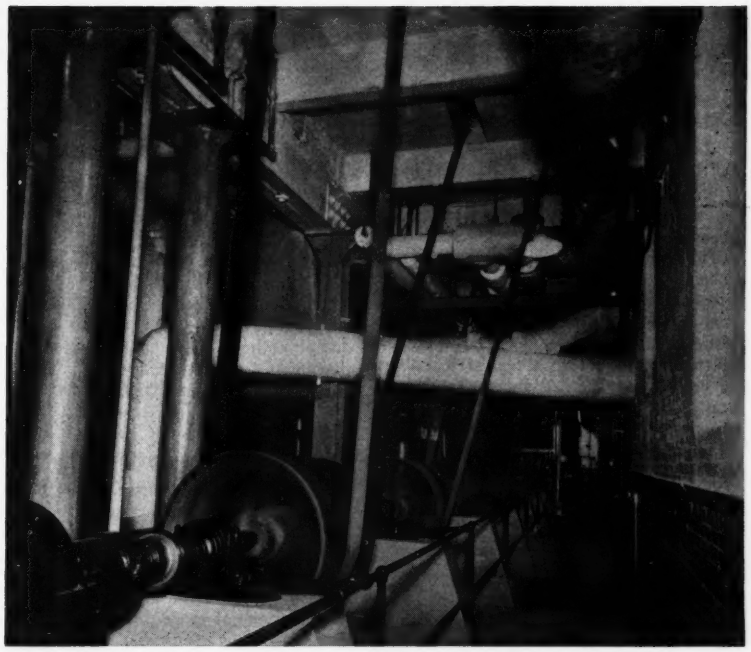
The Stephen-Boltzman law, used so freely by the more learned members of the profession in connection with heat transfer, states that the heat radiated from a surface increases as the fourth power of the absolute temperature. Thus increasing the temperature about 400 deg. F. from 1600 to 2000 deg. F. practically doubles the heat radiated.

* * *

A new plating process which deposits iron in thicknesses up to ½ in. may be used to build up a mass of metal into a mold or die, from the pattern, so as to reproduce without the necessity for engraving fine lines on the hard steel surface.

* * *

A modern boiler unit has no definite rating and predictions before installation and test is a matter of experience. In old plants the limit was likely to be set by the stoker or fans while in new units it is more likely to be slagging or the reduction in mill output due to wet coal.



Belt Drive in Paper Mill

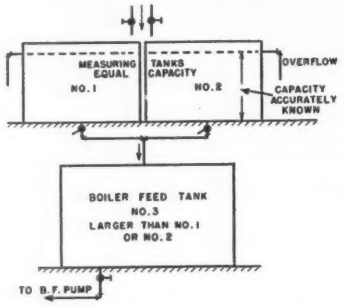
In the Mechanicsville, N. Y., plant of the West Virginia Pulp and Paper Co. is a new paper machine driven by seven 8-in., 10-ply belts spliced endlessly on the drives. All seven of these "fixed center back drives" are variable speed, changed by shifting the belt on the two cone pulleys. Paper speed of the machine is from 100 to 800 ft. per minute and at 750 ft. paper speed the horsepower required is as follows: couch, 45; dual press, 38; first section dryer, 45; size press, 13; second section dryer, 21; first calender, 13; and second calender, 13. These belts were made by B. F. Goodrich Co.

Letters and Comments

Don't Guess, Be Sure

UNDER THE title, "Don't Guess, Be Sure" in the October issue, B. W. Whitehouse describes a simple and effective method of measuring the water for a boiler test. I think, however, that where possible, it is better to use three tanks instead of two, as it is less likely to encourage errors in operation.

Even a simple test costs an appreciable amount of money, if everything is taken into account, as a test of less than 12 hr. is not very satisfactory, and generally one of 24 hr. is better. This means that in addition to the fireman, at least three, and possibly four men must be on duty every minute of the time, and if anybody makes a mistake, and omits to keep his records straight, the whole test is invalidated. This being the case, anything that is likely to minimize the chance of error is worth while.



Three-Tank Arrangement Used for Testing Boilers

With three tanks, two being used for measuring, arranged approximately as shown by Mr. Whitehouse, and one for supplying the boiler (see sketch herewith), we can eliminate the use of the hook gages, which have to be read every time a tank of water is used, as with three tanks, we dump the whole capacity of the measuring tank, and of course its capacity is accurately known, all that is then necessary is to insure that the number of dumps is accurately recorded, and even for this purpose a simple recording device can easily be installed, such as a float in each tank which will operate a numbered dial each time the water is dumped. On the other hand, however, no encouragement should be given to the man in charge to leave his tanks and he should, of course, record the temperature of the water each time.

At both the beginning and end of the test we shall have to measure the depth of the water in the lower tank and, of course, we must know the amount of water per inch of depth, but this is a constant and we only have to figure it once.

If the operators slip up now and then on such matters as temperatures and do a bit of faking, it is not likely to have a great deal of effect on the final result, but if the water record is not accurately kept, the test is absolutely worthless.

I find that it is not so easy to keep everybody on his toes for, say, 12 hr. at a stretch, and anything that will simplify the operation and reduce the chances of error, is decidedly worth while.

Of course, the capacity of the lower tank from which the water is fed to the boiler should be greater than that of one of the measuring tanks, so that we can dump another load in before there is any chance of its running dry.

JAMES O. G. GIBBONS.
Bloomfield, N. J.

My Only Contact

YOU ARE NOT, of course, aware of the fact, but my only contact with the trend in modern engineering thought and practice, is through the columns of your fine publication. I have never seen a boiler carrying more than a 150 lb. pressure nor a turbine of more than 3000 hp. Yet, thanks to POWER PLANT ENGINEERING, I could talk understandingly and ask questions of a man in charge of a modern plant, which would merit his interested and, no doubt, courteous attention.

In this connection, I was much pleased on my vacation to meet an engineer to whom I had already been introduced—although never having met him. "Your name Parker—Heck, I know *you*—You're the guy from Peterboro who writes to POWER PLANT ENGINEERING—*Where* do you get all your ideas?"

It was a pleasing, though somewhat sobering thought, to reflect that in the same manner, I, with my little plant up here at the foot of Monadnock, have gone in to every engine room of importance in this and I don't know how many other countries. I *do* know that an engineer in South Africa would know me as I received a letter from him helping me in my brake troubles.

I wonder if you aren't overlooking a bet? Possibly you could extend your subscription list amazingly. Listen to this. It's true.

I was in the barber shop just after receiving the last copy of POWER PLANT ENGINEERING and passed the time pleasantly, waiting my turn reading an article or two. When I got out of the chair, POWER PLANT ENGINEERING was gone. "What you lost?" queried the barber.

"Well, I had an engineer's magazine, but it seems to have disappeared."

"Why, is this *your* magazine?" asked a somewhat confused lady patron. "I saw the word *'Plant'* on the cover and my geraniums haven't been doing at all well."

Peterboro, N. H. A. H. PARKER.

Report Accidents

A SUGGESTION: On page 86 of the October issue is an article entitled Accidents in the Refrigerating Plant. I think such articles should be moved over into the Practical Engineer and Electrician section and made a permanent part of it.

Whenever an accident occurs and is brought to the attention of the editors of POWER PLANT ENGINEERING, it should be printed and, if possible, accompanied by photographs and sketches.

I think, and always have thought, that too much stress can never be put on the dangers that lurk in and around plants of every type and size. When these accidents do occur, however few and far between they may be, they frequently take somebody's life with them, to say nothing of the property damage and loss of time and production. The descriptions of these accidents should be made clear enough so as to bring to light the real danger, the cause and the preventive measure to be taken, in order that somebody else may not make the same mistake. Regardless of how long we may have gone without an accident or regardless of how careful we may be, the danger is always there and a severe reminder of the results should be of priceless value. CHAS. W. PARKS.

Baltimore, Md.

(It is a good idea and these pages are for the best use you can make of them.)—Editor.

Questions and Answers

Air in Hot Water Radiators

THE EXPANSION tank for my hot water heating system is located in the basement and I have some trouble with air in the radiators. Would a layer of oil on top of the water in the tank prevent transfer of air from tank to radiators, and would there be much danger of oil getting into the boiler, provided there is always plenty of water in bottom of tank? P. S. R.

Oil in Boiler

WHAT IS an approved method of removing oil from a boiler? M. C.

AFTER emptying the boiler pour several pails of soda ash solution into it. Fill the boiler with water and fire gently for several hours, not allowing pressure to exceed 15 lb. From time to time let out part of the water and replace it with fresh. Continue for about 12 hr. Cool boiler, empty if and rinse with fresh water.

Sanitize—Or Else

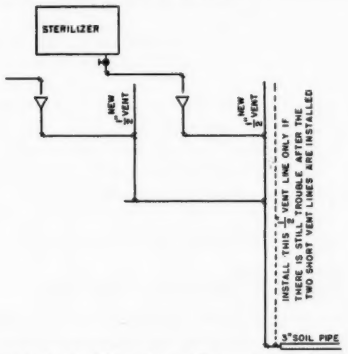
To A. H. PARKER, who is having trouble with his soil pipe as related in the October issue, I would make the following suggestions:

1. See that curb trap and vent cover holes are clean.
2. Connect funnel as close to sterilizer as possible.
3. Increase size of funnel and size of pipe, using 45's instead of ells.
4. Check 1¼ in. vent line pipe.
5. Install 1¼ in. vent line higher than top of sterilizer by using a tee instead of ell on second fitting.

EDWARD SILVERMAN.
Philadelphia, Pa.

* * *

REFERRING to the communication from A. H. Parker, entitled "Sanitize—Or Else" in your October issue, he is undoubtedly right in assuming that the trouble is caused by air binding, and if he will install vent lines at the points shown on the accompanying sketch, it will probably overcome the difficulty.


STERILIZER
NEW 1¼ VENT
NEW 1¼ VENT
INSTALL THIS 1¼ VENT LINE ONLY IF THERE IS STILL TROUBLE AFTER THE TWO SHORT VENT LINES ARE INSTALLED
3" SOIL PIPE

Method of Venting to Prevent Overflow

If these two vents do not entirely overcome the trouble, an additional vent could be run from the connection to the 3-in. soil pipe. With the system vented at these three points, it is difficult to see how any further trouble could possibly occur.

As open funnels are allowed, it would no doubt be permissible to have the vents discharge inside the building, in which case, it would only be necessary to run them up as high as the tops of the funnels. JAMES O. G. GIBBONS.

Bloomfield, N. J.

For the Operator

Valve Setting After Engine Repair

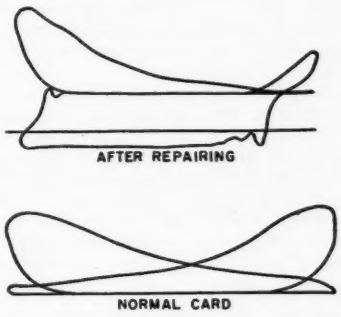
By George W. Redman

HERE ARE indicator diagrams which were taken from an Erie Ball 4-valve engine 23 by 27 in., 150 r.p.m., 150 lb. pressure, 3 lb. back pressure driving a 250-kw., 250-v. generator. The chief engineer had ordered the engine overhauled. The head was removed and the cylinder, piston, rings and valves were checked and found ok. A top gasket was renewed. Eccentrics checked and found ok. All valve rod, reach rod and governor bushings were renewed. Crank pin bearing was rebabbitted. Main bearing checked; new metallic packing installed on rod and alinement checked.

With all this preliminary work out of the way, the engine was turned over without steam and then started up and partial load put on with the No. 1 card resulting. Horrors!

The operating engineer was ordered to throw the engine on crank center and block open the governor and set the valves according to the marks on the valves and chamber. The crank end lined up but the head end refused to line up by a good 3/16 in. As the manufacturer's engineer was not available, several engineers and shop men were called in with net result of no progress after several days. The No. 1 type of card persisted with a few variations.

When the chief, who was working in another plant, came in, he decided to try his hand. All jacks and equipment were removed from the flywheel and he ordered the men to start from scratch again. Because it was inconvenient and hard to get jacks to work in that position, the engine was jacked with piston to the head end. This had been done the first time also.



Indicator diagrams illustrating results of first and last valve adjustments

The chief had the crew throw it on crank end and jack the governor open from there with the result that the valves were lined up line and line, and when engine was started and set by the indicator the No. 2 card resulted. The engine has been running without trouble ever since.

Clean Boilers and Efficient Auxiliaries

By W. F. Schaphorst

I HAVE before me a report on a plant having boiler repairs running to about $4500 per year. They installed modern water treating apparatus and after five months' use they reported that the total saving due to the apparatus was $8670 on a five months' run, or an annual saving of $20,880. This apparatus also saved the old boilers from being condemned by the boiler inspector. The water contains 99.6 grains of scale-forming substances per gallon.

Another concern using very undesirable water sent in the following report: "We have saved between $4000 and $6000 in water cost alone, besides the benefits which we have procured in the way of decreasing boiler cleaning costs and better operation of the boilers."

Tube cleaners, soot blowers, water softeners, deconcentrators — all such equipment for keeping boilers clean is usually highly profitable.

A large Canadian concern having six 600 hp. boilers could not maintain

PUMP CONSTANT

WE HAVE the problem to find a way to figure the tons of coal used daily by two boilers. We operate at 150 lb. pressure, generate some of the power, using the exhaust steam for heating the buildings at 3 lb. back pressure and 18 in. vacuum. The plant engineer wants the amount of coal used reported daily instead of monthly as was done prior to this year.

Back in 1935 an outside company ran a working test of our plant and found that 1 lb. of coal evaporated 9.6 lb. of water into steam. Our duplex feedwater pump averages not more than 60 strokes per minute.

Our present method of estimating the amount of coal used per day is illustrated by the following example:

Readings of counter on pump are taken at 12 o'clock midnight.

Tonight	**35,687**
Last night	**22,850**
Revolutions	**12,837**

12,837 × 16.5 (empirical constant) = 211,810.5 lb. water evaporated. 211,810.5 ÷ 9.6 (lb. water evaporated per lb. coal, established by test) = 22,064.6 lb. or about 11 tons of coal.

The pump has a 27 per cent slip due to wear and its dimensions are 7.5 by 5.5 by 10 in.

Is there a better method than this? Our difficulty seems to be in establishing the empirical constant. We have used 19.6, 15 and now 16.5.

H. F.

a superheat of more than 50 to 60 deg. F. over any reasonable period of time. They installed a modern steam purifier. They state that they are now obtaining a steady average superheat temperature of around 100 deg. which is the theoretical temperature they should have obtained with dry steam from the boilers to the superheater.

Before the purifiers were installed they could not carry over one and one-half gages of water in their boilers because of tremendous foaming and priming difficulties. Since the installation of the purifiers they have run their boilers constantly with water level approximately at middle gage. But even at full gage they don't get any drop in the superheat. Before the purifiers were installed they had to dismantle and clean the turbines every six months. Now, inspection shows them to be perfectly clean.

When first putting this plant in operation, they did not have a water softening plant. In order to try to correct the above troubles they installed an intermittent system. This feedwater treatment system takes care of the scale forming material so that they have no further trouble with scale in their boiler. But it did not, in any way, decrease priming and foaming troubles. All of which teaches a valuable lesson on the importance of clean steam.

Where there is too much exhaust steam—so much that some exhaust is wasted—it is usually best practice to run auxiliaries electrically or mechanically rather than by steam.

But where there is insufficient exhaust for heating or processing it is usually best to operate the auxiliaries by steam rather than to use bleeder steam for heating or processing systems.

We frequently hear the excuse where steam operated auxiliaries are used that the exhaust is used for heating the feedwater anyway, hence there is no loss. But when the main engine is being utilized, the loss is obviously as great as where the exhaust from the main engine is used for water and the steam from the auxiliaries is being wasted.

To be certain that the power plant is efficient throughout every process must be considered. It is impossible to lay down a hard and fast rule applicable to every plant. The thing that the owner is most interested in is maximum production per dollar invested rather than maximum efficiency.

PRACTICAL HINTS AND KINKS

Lubricating Concrete Forms

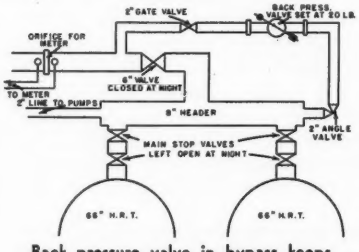
CONCRETE pontoons used for the new Lake Washington Floating Bridge were poured in special graving docks and then floated to their position. The wood veneer forms were treated so as to prevent sticking of the concrete, with subsequent pock marks on the finished pontoon which would have to be patched and smoothed over.

The lubricant used was a mixture of Union Diesol and paraffin wax mixed in the proportion of one gallon of Diesol to one pound of wax. The mixture was heated to the boiling point and the veneer pieces placed in the mixture until they were saturated. After this they were allowed to drain and dry before being placed in the forms.

Safety Valve Annoyance Stopped

By M. R. O'Brien

WE HAVE two 66-in. h.r.t. boilers fired by two rotary burners burning No. 6 oil. I recently cut the pressure from 50 to 25 lb. Formerly, we could drop the pressure before shutting down at night and leave the drafts open and the boilers would not build up enough pressure to blow the safety valves. But after cutting the pressure they would blow several times during the night. The students and neighbors started to complain so I had to do something about it.



Back pressure valve in bypass keeps piping hot

The two boilers are tied into an 8 in. header and the main line to the buildings is taken off this through a 6-in. valve which we close at night. I ran a 2-in. line from the end of the 8-in. header to the low pressure side of the 6-in. valve and put a back pressure valve in this 2-in. line and set it for 20 lb.

Now we can close the drafts tight when we shut down and don't have to cool the settings, thus relieving considerable strain on the boilers and brick work.

The back pressure valve opens up at least three times during the night. The steam keeps the main lines hot all night so when we start up in the morning it isn't such a drag to pick up the load.

Clearing Root Obstructions in Sewers with Caustics

By Paul C. Ziemke

ROOTS of soft woods such as willows and poplars constitute a serious nuisance to property owners who annually are confronted with expenses incurred through digging up or force cleaning methods of their clogged sewers.

Herewith are offered several valuable suggestions:

Copper rings installed in the joints at the time of laying the sewer are quite effective in preventing root entry at that point since the chemical reaction present between the copper, the earth and water minerals has destructive effect on the root fibers.

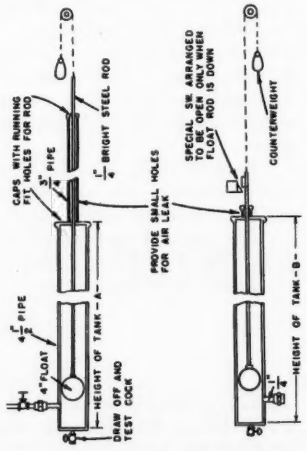
Once the roots have entered, however, other means must be employed otherwise stoppage will soon occur. For that task a method that has proven successful consists of introducing copper sulphate into the sewer where the capillary action of the roots soon draws in the caustic and accomplishes their early destruction and decomposition.

The quantity of sulphate must not be too large, a cup full being sufficient under most conditions when mixed with three cups of warm water and poured into the basement floor trap or into the toilet bowl where no floor trap exists.

Best results of course are obtained when the caustic is applied at night so that it may slowly trickle through the root entangled stoppage.

Float Chamber Design

WATER LEVEL indicators of the float type can usually be constructed from odds and ends available around the plant. Several different designs were proposed in Problem 9 on page 78 of the May issue. The attached drawing shows the details as proposed by James O. G. Gibbons who received the third


CAPS WITH RUNNING FIT HOLES FOR ROD
3/4" PIPE
1/4" BRIGHT STEEL ROD
PROVIDE SMALL HOLES FOR AIR LEAK
SPECIAL SIR ARRANGED TO BE OPEN ONLY WHEN FLOAT ROD IS DOWN
COUNTERWEIGHT
1/2" PIPE
4" FLOAT
HEIGHT OF TANK - A -
DRAW OFF AND TEST COCK
HEIGHT OF TANK - B -

Water level indicator and low-water alarm

prize award. The float chamber on the left is arranged so as to give a direct indication of the water level while that on the right has electrical contacts to serve as a low water level alarm.

Plumber's Tape for Tube Cleaning

By Chas. W. Parks

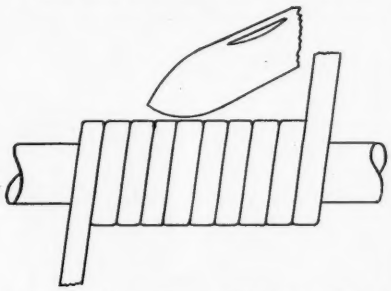
How MANY times has a fireman been given charge of a boiler cramped back against the wall with just about room to walk? And how many times has he had to punch tubes by making up pieces of pipe as he pushed the brush through the tube and taking it apart again when taking it out? Well, here is how I got around that task. I took a three-quarter-inch plumber's tape and fastened the tube brush securely to the end of it. With this you can push all of the tubes without making any connections or breaking any. The tape is strong enough to be fed through the tubes and yet flexible enough to bend around the corners when taking it out.

By rigging up a series of different sizes and shapes of brushes and scrapers, this device can be used to advantage around any kind of tubes, in condensers, heaters, coolers and where tubes of all sizes are used. Where painted machinery is located near where you have to work, if the tubes are not too small, thread the plumber's tape through an ordinary garden hose. This is quite a job and takes patience, but it can be done and when it is, the labor is well rewarded. The hose serves as a protector for paint, pressure gages and small fittings that it may happen to strike while working.

A Packing Short Cut

By P. F. Christopher

As NEAT a trick as I've seen in a long time is the following dodge for cutting packing for small valve stems and rods. Using the valve stem, or a straight bar of the same diameter, wind several turns of packing around it exerting a firm pull in making the turns to cre-



Use of valve stem as mandrel for cutting packing

ate a slight tension in the packing. Then run a sharp knife back and forth on the turns at any convenient point, cutting the packing about half way through. Remove the turns and separate the links.

The slight stretch caused by tension will retract when the rings are separated producing just about the right gap between the ends when the packing is applied.

This works with any packing and any rod, but with the larger sizes the packing is heavier, of course, and it is impossible to exert enough tension to make it stretch. It simplifies matters a good deal, however, to trim several rings cut in this manner instead of cutting and fitting each ring individually.

Water Handling and Pumps

Suction Lift of Hot Water in a Reciprocating Pump

By George Blum

ONE OF the most important operations in the combustion power plant is the pumping of hot boiler feedwater. Lifting this water from a hotwell and forcing it into the boilers against pressure is a duty often performed by the duplex reciprocating pump, a simple form of which is shown in the accompanying diagrams. The most common fault found with this type pump is that it often fails to lift hot water anywhere near the height theoretically possible for a given water temperature. A little study of the principles involved will show why the pump does not lift the water the theoretical height and what can be done to increase the lift or to increase the temperature of the water, an often desired improvement.

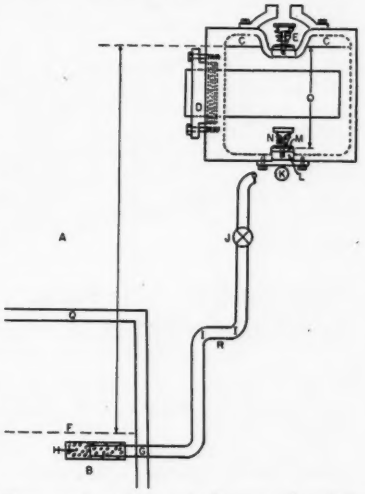
There are several common causes of decreases in the suction lift, which, for a pump at sea level, water at 32 deg. and having a perfect vacuum above it, is approximately 34 ft. First is a fall in atmospheric pressure, as shown by a barometer and represented by A in the diagram. At B is represented the increase in water temperature and the resulting increase in counter-atmospheric pressure of the water vapor formed at the lesser pressure of the greater height, shown at C. The decreased density of the heated water tends to offset the effect of the vapor pressure, but to no great extent. At temperatures approaching the boiling point the vapor pressure increases much more rapidly than the expansion of the liquid.

Factors of design, installation, repair and operation which affect the lift are these:

Of design and installation: K, suction orifice too small. L, suction valve too small. M, valve seat too wide. N, too much tension of suction valve spring. O, valve in such position that a head of water lies upon it. R, suction line too small or longer than necessary. I, suction line having too many bends. J, globe valves in line, or partly closed gate valve, increasing pressure drop. G, intake of hotwell too high, eddy currents carrying air into the pump. Q, hotwell not properly vented to admit atmospheric pressure freely.

Of operation and repair: J, partly closed gate valve. F, failure to keep level of water in hotwell high. B, leaks of air into suction line. D, leaky packing on pump rod, or plunger if outside packed. H, clogged strainer. N, replacing suction valve spring with stronger one. E, leaky discharge valve.

As the plunger moves on the suction stroke, space occupied by the vapor increases until the suction valve opens. If the valve spring is too strong, the resultant surge of water upward when it does open is a frequent cause of pounding. Few operators realize that the action of this valve is almost identical with, although milder than, the safety valve of the boiler.



Pump cross section and diagram of suction piping

Before it can open, the total pressure upon the under surface of the disk must be greater than the total pressure upon the upper surface. In all cases the area of the upper surface will be greater than the area of the under surface by the effective area of the seat. Even without the effect of the spring, the pressure above must fall until it is much lower than that below before the valve will open. When the space C equals the plunger displacement, no water can be drawn into the cylinder.

As soon as the plunger reaches the end of its stroke the spring closes the suction valve. At once the mixture of water and vapor left in the suction line stratifies, a pocket of vapor forming just under the valve seat. Like the pocket of vapor in the cylinder, the extent of this pocket will depend on the temperature of the water. If large enough, this pocket of vapor may cause the plunger to slip.

Traps for Paper Mill

AT THE NEW mill of Hollingsworth & Whitney Co. at Mobile, is a typical example of a carefully engineered condensate removal system. To better appreciate the problems involved, one

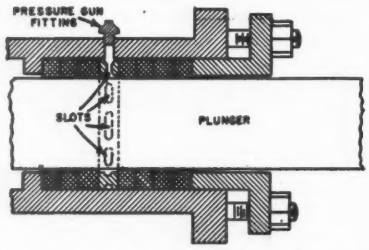
should consider that the pressures used for power and process work range from 600 lb. super-heated steam with 780 deg. F. total temperature, down to low pressure process lines carrying 30 lb. maximum. Capacity requirements on individual units to be trapped varies from small heating units, condensing as little as 100 lb. per hour, up to large digester heaters with a possible maximum condensate load of nearly 100,000 lb. per hour at the peak.

As installed in the new mill, forged steel inverted bucket traps are used on high pressure steam lines carrying 600 lb. (780 deg. F.). Semi-steel inverted bucket traps are used throughout on 30 lb. and 130 lb. process and heating lines. Special large capacity open bucket type traps, with semi-balanced valves, suitable for condensate drainage up to 100,000 lb. per hour are used both on digestor heaters and evaporators. These steam traps, supplied by the Strong, Carlisle & Hammond Co., are used in practically all sections of the plant including turbine rooms, boiler rooms, bleach plant, digestor building, evaporator room, causticizing plant, recovery room, pulp dryer room, machine room, beater room, finishing rooms, fuel oil system and heating system.

Pressure Gun Aids Pump Packing Lubrication

By S. H. Coleman

THE TROUBLE-FREE performance of both inside and outside packed plunger type reciprocating pumps depends to a great extent on packing selection and maintenance. Because this particular class of pump has many and varied applications the choice of suitable packing materials must necessarily be governed by the requirements of the individual installation. Not only must



Pressure lubricating gun applied to pump packing

the packing be designed and built to seal effectively the liquid chambers of the pump with a minimum of friction and wear on plunger surfaces, but it must also be able to retain these characteristics for long periods of time even though it is exposed to adverse conditions of temperature and pressure or to the deleterious action of physical or chemical properties of the fluid handled. With these factors in mind it is obvious that hit or miss methods of selecting packing for this type of pump or for that matter any application should be discarded. In their place should be substituted close coöperation with a reliable packing manufacturer whose engineers through long experience and research are in a position to recommend the class and form of packing material that will give long and satisfactory service on the job for which it is specified.

Although a pump packing may be entirely suitable for a given application it cannot be expected to remain so indefinitely without a reasonable amount of maintenance attention. While such care is usually confined to renewals and the adjustment of glands to prevent excessive leakage without compressing the packing too much, plunger pump packings frequently require a certain amount of lubrication both to keep them soft and to reduce plunger friction. Ordinarily, a mixture of graphite and cylinder oil or some special lubricating compound, applied directly to the plunger while the pump is running, is used for this purpose. This method of applying lubricant has a number of disadvantages, however, among which are its messiness and the impossibility of securing an even distribution on plunger wearing surface and in the stuffing box.

A much more efficient lubricating scheme is shown in the drawing. This consists of a metal ring grooved on its inner and outer surfaces, with an inside diameter slightly greater than that of the plunger and an outside diameter that enables it to slide into the stuffing box without binding. When packing is installed this ring is placed about midway of the packing space so that its groove is in line with a pressure gun fitting, through which the lubricant can be forced. A number of slots between the grooves on the ring insures the lubricant reaching all points on the circumference of the plunger.

Refrigeration and Air Conditioning

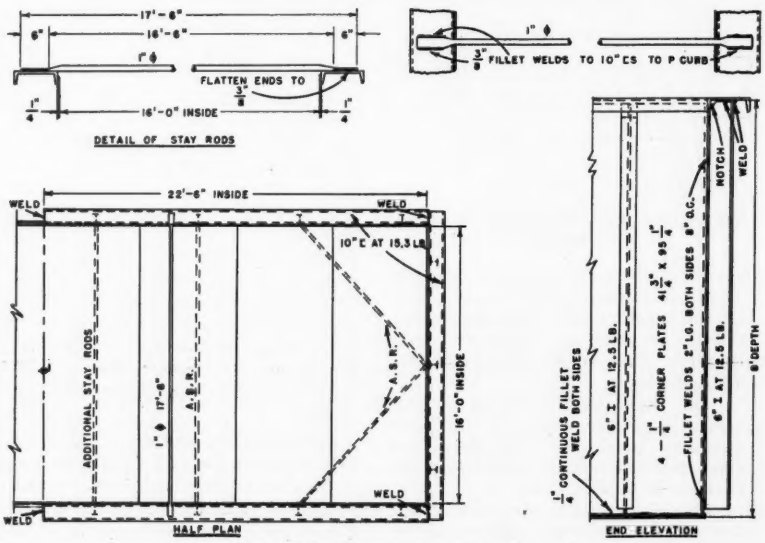
Fire Hazards of Welding

By Anthony A. Fette

WHILE FIRE HAZARDS in connection with welding are apparent, our experience with the installation of a new brine tank is indicative of the danger involved even when care has been exercised to avoid possibility of fire.

This tank was installed on pedestals, on 3 ft. centers, which because of a slope in the floor varied from 18 to 27 in. high. On top of the pedestals were imbedded two 3-in. angle irons with the flat sides up. On these angles were placed 2-in. linseed soaked, oak planks for flooring. This was then covered with tar paper, 4 in. of cork and finally the tank bottom. This arrangement allowed space under the tank for a man to crawl for inspection or repair.

This tank, 16 by 45 ft. and 8 ft. deep, was made of ¼ in. thick steel sheets to be welded in place. On the floor of the tank 3 in. thin strips of steel were laid on the cork under the joints so as to prevent setting the cork on fire when the joints were welded. Ten inch channel iron was welded all around the top of the tank with 6-in. I beams down the sides on 6 ft. centers for reinforcement. Two 1-in. tie rods equally spaced were welded on top of the channel iron for additional bracing, across the top of the tank.



Brine tank dimensions and details

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THE Nalco SYSTEM OF FEEDWATER TREATMENT

Incidentally, the contract cost on the tank, the cooling equipment, steel shoring, pipe work, insulation and oak flooring amounted to a little over $7600, some of which are listed in the table. Other incidentals which we did ourselves brought the total cost to somewhat over $9000.

This new tank was placed about a foot from one wall and this space was filled

Some of the contract costs of the equipment and tank

Brine Cooling System	$2,594.00
Brine Tank, Erecting	673.70
Brine Tank, Furnished	1,168.00
Pipe Work	2,282.77
Cork Work	424.00
Cold Storage Doors (Top)	52.00
Oak Floor	129.84

in with granulated cork with cement plaster on top. The exposed three sides were insulated with 4 in. of block cork covered with a half inch of cement plastering. The steel strips mentioned above prevented fire during tank construction. Later, however, it was decided to add two brass copper wire strainers with a butterfly valve at the end of the return pipe so that the brine could be shunted to either of the two baskets. A cage was built to hold these strainers and it was welded to the plate in the side wall of the tank. After several days a fire broke out due to cement plaster covering the granulated cork. This fire was promptly put out with a water hose, the burned cork replaced and patched up.

After the tank was tested additional reinforcement was thought necessary and the contractor welded attachments on the inside of the tank walls for eight additional tie rods. Several weeks later another fire, which had evidently been smoldering all this time, broke out through the top and ends of tank at wall.

Steam Jet Refrigeration

WHERE STEAM is available and large quantities of water at temperatures of not lower than about 40 deg. F. are needed, steam jet refrigeration can be used to advantage. A diagrammatic installation of this kind is shown by the drawing. Water to be cooled is sprayed into the evaporator. The primary ejector, using a steam jet, creates a high vacuum of perhaps 29.75 in. Hg. on this evaporator. Part of the water evaporates and cools the balance, the evaporated vapor being carried over, through the ejector to the primary condenser.

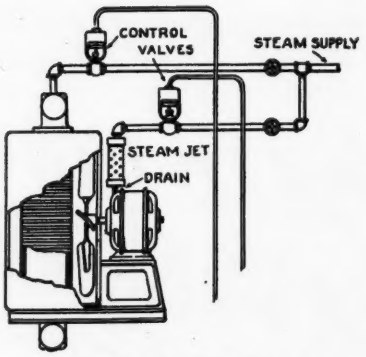
Because of the high vacuum necessary the three ejectors are used in series as shown, the secondary ejectors with the inter-and after-coolers being similar to the arrangement commonly used on a surface condenser. Inasmuch as the steam or water vapor is condensed between stages, the secondary ejectors handle only the non-condensible vapors and are therefore smaller than the primary ejector.

Where the warm condenser water at temperatures of from 85 to 95 deg. F. can be used in process work this arrangement gives a perfect heat pump, heat taken from the cold side being reclaimed and used in the warm side. Unfortunately such combinations are rare and, like as in a steam condenser, the cooling water must usually be run to waste or recirculated over a cooling tower.

Winter Humidity Control

ONE OF THE COMMON winter heating problems, in locations where there is a high leakage or infiltration of cold air, is keeping the humidity up to the level of comfort. This can be varied over a considerable range but in air conditioning work a relative humidity of 10 per cent below the outside, with a minimum of 50 per cent, will be satisfactory.

During cold weather moisture in the outside air condenses out so that the absolute humidity is low. This relatively dry air, coming in heated room, warms up and the relative humidity drops accordingly. With unit heaters a steam jet may be used to increase the humidity as shown by the drawing. The steam valve may be controlled automatically by a hygrostat or by hand. The accompanying table presented by the Armstrong Trap Magazine shows the pounds of steam required to humidify 1000 cu. ft. of space under different conditions assuming two air changes per hour and an inside temperature of 70 deg. F.

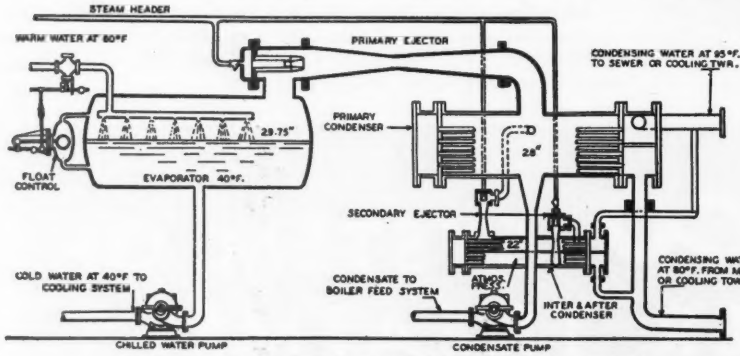


Steam jet used with unit heater

Where high humidity must be maintained all the year 'round, this method is not so satisfactory because the heat content of the steam during summer months may be undesirable. In this case mechanical or air jet atomization to break the water into a fine mist or spray may be used advantageously.

Pounds of steam required to humidify 1000 cu. ft. of space with various outside temperatures and relative humidities. This table prepared by the Armstrong Machine Works is based on two air changes per hour and an inside air temperature of 70 deg. F.

Average Percent of Saturation (Outdoor)	Outdoor Temperatures	Relative Humidity Desired 25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
65	35°	.137 lbs.	.252	.376	.483	.598	.713	.830	.943	1.057	1.175	1.288	1.409
70	30°	.188	.304	.418	.535	.648	.763	.880	.995	1.108	1.225	1.341	1.452
75	25°	.243	.357	.472	.588	703	.817	.934	1.048	1.162	1.281	1.395	1.508
80	20°	.292	.406	.520	.638	.752	.867	.982	1.096	1.212	1.328	1.442	1.557
85	15°	.335	.449	.563	.680	.794	.910	1.025	1.141	1.255	1.372	1.486	1.600
90	10°	.372	.486	.600	.717	.830	.945	1.061	1.177	1.282	1.408	1.524	1.635
90	5°	.408	.523	.637	.754	.868	.983	1.101	1.215	1.328	1.442	1.557	1.671
100	0°	.440	.555	.668	.787	.900	1.015	1.131	1.245	1.360	1.478	1.592	1.705
100	-5°	.475	.588	.702	.820	.934	1.049	1.167	1.282	1.395	1.512	1.623	1.738
100	-10°	.503	.615	.729	.847	.961	1.076	1.194	1.359	1.422	1.539	1.650	1.765
100	-15°	.529	.642	.756	.874	.988	1.103	1.221	1.386	1.449	1.566	1.677	1.792
100	-20°	.551	.664	.778	.896	1.010	1.125	1.243	1.408	1.471	1.588	1.699	1.814
100	-25°	.572	.685	.799	.917	1.031	1.146	1.264	1.429	1.492	1.609	1.720	1.835



Diagrammatic arrangement of steam jet refrigeration equipment

In a small emergency foundation job where water could not be kept out of the excavation and sheet piling was not available, cement bags were piled up and allowed to harden. The next day the pit was pumped out and the footing built up immediately. Expensive perhaps, but it did the job.

* * *

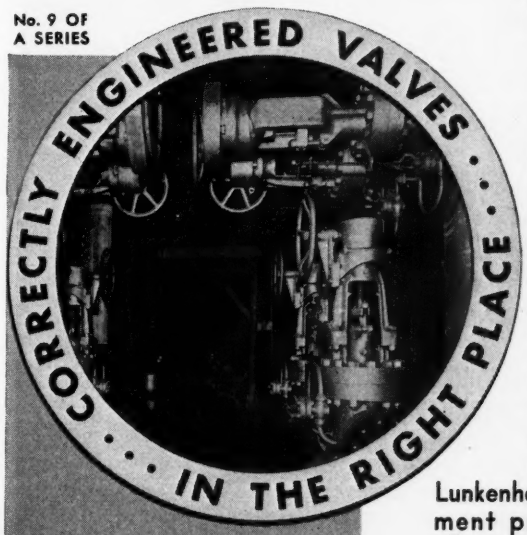
A new fire protective instrument which operates at the temperature of a standard sprinkler head, or approximately 160 deg. F., can be used to give a warning of excessive heat from any cause before a fire is actually started. That's relegating our Hero's sprinkler system to standby service.

Reflecting Continual Improvement and Refinement, Including Developments of Exceptional Interest During 1940 . . .

LUNKENHEIMER *STEEL VALVES*

. . . ARE "CORRECTLY ENGINEERED" FOR MAXIMUM ECONOMY ON THE JOB!

No. 9 OF A SERIES



● Due to the peculiarities of their service requirements, involving as they do unusually high temperatures and pressures, the business of designing and producing steel valves becomes a highly specialized one . . . one which requires constant research, development, and engineering experience. In this particular field, Lunkenheimer has taken an important lead in improving and refining both the design and materials used . . . the two special steel gate valve patterns illustrated being truly representative of this "engineered superiority."

Lunkenheimer Steel valves are available in a wide range of types and sizes and in a variety of body as well as trim materials to suit all prevailing service requirements. And, as new conditions develop, Lunkenheimer's constant program of reseach and improvement promises the surest, most dependable solution to whatever new problems are encountered.

LUNKENHEIMER 1500 LB. S. P. STEEL GATE VALVE with Welded Bonnet for Burlington and Marion Generating Stations—Public Service Electric & Gas Company.

SEEING IS BELIEVING! We welcome the unusual opportunity afforded by the Power Show in New York to describe Lunkenheimer products in detail and point out visible points of superiority which assure better, longer, lower cost service. In addition to the two big steel valves illustrated, you'll find a variety of bronze and iron body bronze mounted valves for your careful inspection.

LUNKENHEIMER 2500 LB. S. P. "TWIN BRANCH" STEEL GATE VALVE, Seal Welded Bonnet with Breech Lock (Patent Applied For) for Twin Branch Generating Station — Indiana & Michigan Electric Co.

Send for copy of our new Catalog No. 78. We will include our handy "Guide," which makes selection easy by grouping valves, boiler mountings, and lubricating devices according to pressures, temperatures, and service applications.

●

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"QUALITY"

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BOSTON PHILADELPHIA

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LUNKENHEIMER

POWER REQUIRED TO PUMP WATER
A
B
C
D
E
F
G
H
I
DIAMETER OF PUMP CYLINDER-INCHES
STROKE OF PISTON - INCHES
THEORETICAL DISPLACEMENT-GALLONS PER STROKE
CUBIC FEET
STROKES PER MINUTE
THEORETICAL CAPACITY - GALLONS PER MINUTE
PERCENT SLIP
ACTUAL CAPACITY - GALLONS PER MINUTE
HEAD IN FEET
HEAD IN LB. PRESSURE PER SQ.IN.
THEORETICAL WATER HORSEPOWER
RALPH E. TURNER 1940
PUMP FORMULAS.
SQUARE THE DIAMETER, IN INCHES, OF THE PUMP CYLINDER, MULTIPLY BY 0.7854 AND BY THE STROKE, IN INCHES, OF THE PISTON, DIVIDE BY 231 AND RESULT WILL BE THE DISPLACEMENT IN GALLONS PER STROKE
GALLONS PER STROKE MULTIPLIED BY THE STROKES PER MINUTE GIVES THE THEORETICAL CAPACITY OF THE PUMP IN GALLONS PER MINUTE.
THEORETICAL CAPACITY MULTIPLIED BY 1 MINUS THE PERCENT SLIP EXPRESSED AS A DECIMAL GIVES THE ACTUAL CAPACITY.
ACTUAL CAPACITY IN GALLONS PER MINUTE MULTIPLIED BY HEAD IN FEET AND BY 0.000252 GIVES THE THEORETICAL WATER HORSEPOWER.
CONVERSION OF GALLONS TO CUBIC FEET IS ACCOMPLISHED BY USE OF SCALE C. 1 GAL. = 0.133 CU.FT.
CONVERSION OF HEAD IN FEET OF WATER TO POUNDS PRESSURE PER SQUARE INCH IS ACCOMPLISHED BY USE OF SCALE H. 1 FT. HEAD = 0.433 LB. PER SQ. IN.
EXAMPLE
10 IN. CYL.
12 IN. STROKE
100 STROKES PER MIN.
10 PERCENT SLIP
90 FT HEAD
ANSWER - 8.27 WHP

If Your Water Problem Involves

SILICA REMOVAL

You will be interested in this remarkable BETZ Adsorption Process, using REMOSIL—a distinctive Magnesium Oxide. Three to twenty times as much Silica is removed, at lowest cost, without increase in alkalinity or sulfates and with a decided decrease in hardness and total solids . . . Complete details are reprinted in Technical Bulletins Nos. 63 and 64—from papers presented before the American Chemical Society . . . Through continuous research in laboratory and field, the BETZ Organization keeps "one step ahead" in the application of Chemical Engineering to Water Correction.

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BETZ ADSORPTION PROCESS

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"REMOSIL"

Whether your problem involves Silica or other undesirable contamination, the technical facilities of BETZ Laboratories are at your service—at a very reasonable cost . . . May we suggest that you take advantage of this opportunity to rid your plant of water problems—silica or what have you—through BETZ Service. You can without obligation receive full advice on the Remosil Process or any other phase of BETZ Service.

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New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Inner Ring Bearings

EXTENDED inner ring bearings which are permanently sealed, pre-lubricated and fitted with snap ring as standard equipment against bearing location is announced by the Stephens-Adamson Mfg. Co., Aurora, Ill. These bearings

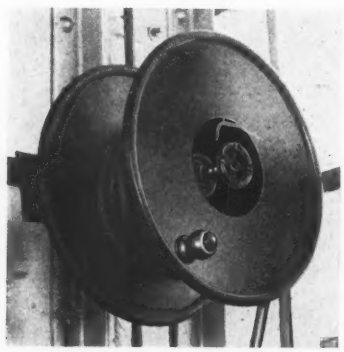
are for machine applications on straight shafts and have the Sealmaster centrifugal labyrinth seal, which is said to retain its lubricant and keep out dirt.

Regreasing is permitted through two holes in the outer diameter of the outer race.

Live Hose Reel

SCHRAMM, INC., West Chester, Pa., announces a new type live hose reel, developed for use on the Schramm portable and stationary air compressors.

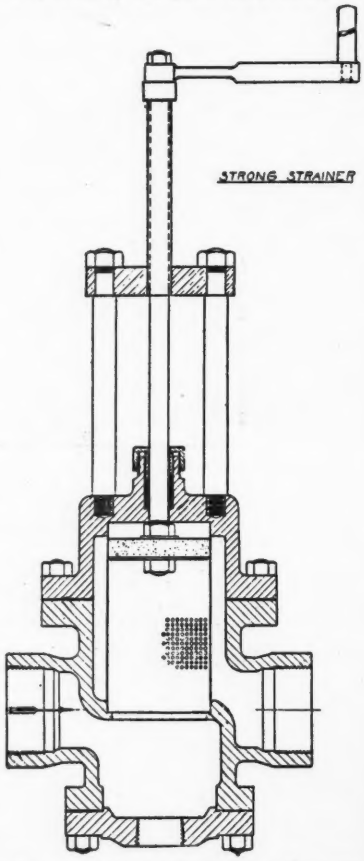
The outstanding advantages of this new reel are easy mounting, said to fit any 1½ in. female pipe thread, built in valve construction; extra strength side members spun and welded to hub, heavy



bronze bushings to support reel, and free turning under all conditions. The reels are designed so that three feet or the entire fifty feet of hose can be pulled from the reel and the valve then opened allowing air or water to enter the hose. The valve is self sealing having no adjustments, packings, stuffing boxes or leaks.

Pipe Line Strainer

STRONG, CARLISLE & HAMMOND CO., Cleveland, Ohio, recently announced a strainer of special construction developed for use in industrial processes where foreign matter to be removed tends to clog the perforations in strainer screen. Turning the lever handle moves the bronze wire brush up and down inside the screen.



The rotation of the brush effectively cleans screen perforations so strainer can function. Wire brush type strainer has application wherever water or steam lines contain matter adhering to screen.

Coated Weldrod

AMPCO METAL, INC., Milwaukee, Wis., announces that aluminum bronze in the form of a coated weldrod is now being produced in several grades for the first time. The usefulness of the aluminum bronze alloys with their properties of wear resistance, high strength, hardness, and resistance to fatigue and corrosion is thus extended to meet the demand for such a material. Ampco-Weld, the new coated weldrod, is a completely new departure in metallurgical accomplishment and is particularly applicable for rebuilding worn cams, gears, dies and bearing surfaces, as well as in original work where the bearing properties and corrosion resistance of the metal can be used to advantage. The unretouched photograph shows a standard 0.505 in. test bar turned of SAE 1021 steel, with

a V-notch weld of Grade 18 Ampco-Weld. This bar broke after 27 per cent elongation in a 2 in. gage length, at 84,000 p.s.i. Note that the steel elongated on both sides of the weld section and necked down before fracture. The Ampco-Weld material, however, still retains its original diameter under the micrometer with little apparent elongation.

Wrench Set

HERE'S WRENCH convenience offered by Snap-on Tools Corp., Kenosha, Wis., for handling and speeding up those tricky little jobs where tiny nuts and bolts are used on such things as instrument boards, ignition systems, meter repair work, etc. Each wrench has an open end and a boxocket end of the same size, and the set includes ¼, $\frac{9}{32}$, $\frac{5}{16}$, and $\frac{11}{32}$ in. sizes. Tightening small nuts and bolts with a pair of pliers often

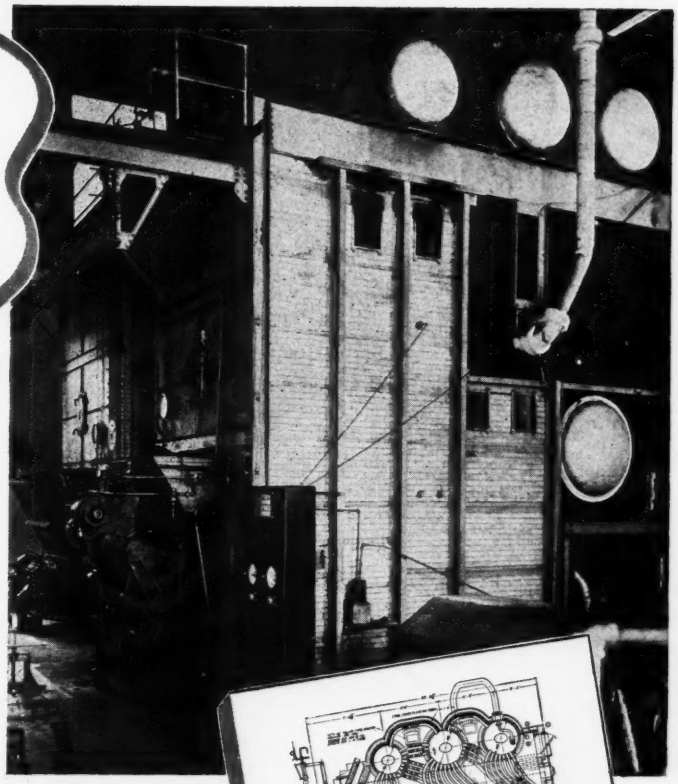
results in their being damaged, whereas the use of midget wrenches protects the job and provides a faster, surer way of servicing those tricky jobs. Each type of wrench opening has its advantage, and the combination of both types on one handle gives efficient wrench service under all conditions.

Two Vogt Boilers

BURN 230 TONS *LESS* COAL

AND *INCREASE* POWER 88%

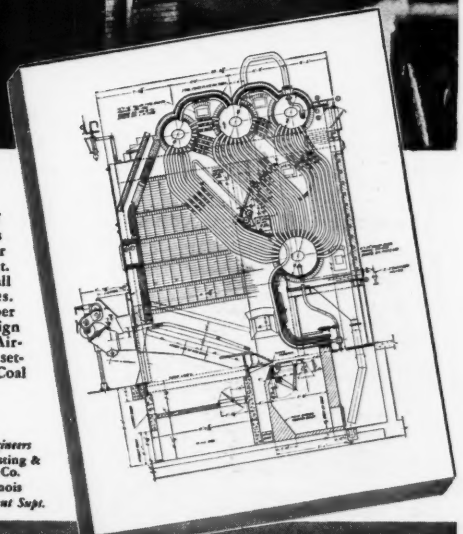
at the
MUNICIPAL LIGHT
AND WATER UTILITY
Richland Center,
Wisconsin



THIS modernly equipped plant, served by two Vogt, four-drum, bent tube boilers, provides dependable, low-cost service the year around for the city of Richland Center, Wisconsin.

A comparison was recently made of the 1939 power output with that of 1935, when boilers of another type, now replaced by the Vogt units, were in service. Plant records revealed that in 1939 a total of 230 tons LESS coal were burned while 2,188,160 MORE K. W. hours were generated than in 1935; a *decrease* in coal consumption and a power *increase* of 88 per cent!

Economize through modernization—Consult Vogt engineers on your steam generating problem!



Data

Each unit has 4,197 sq. ft. of heating surface and generates 35,300 pounds steam per hour with 115 deg. superheat. * Water cooled bridge wall with Vogt armored tubes. * 225 pounds per square inch design pressure. * Air-cooled boiler setting. * Fuel—Coal screenings.

Consulting Engineers
Commercial Testing & Engineering Co.
Chicago, Illinois
R. H. Strang, *Plant Supt.*

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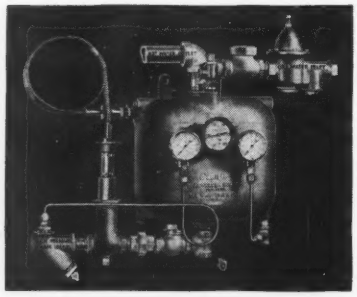
Vogt WATER TUBE BOILERS
BENT TUBE, SECTIONAL HEADER & BOXHEADER TYPES

Injection Type Hot Water Heater

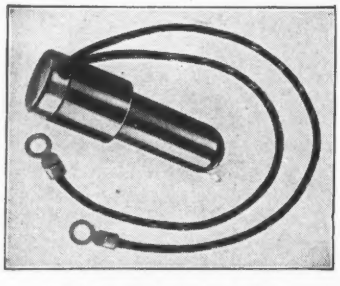
HOT WATER, up to 3000 gal. per hr., at any desired controlled temperature, is available at low cost through a new industrial injection type steam and water mixing unit being manufactured by The W. J. O'Brien Co. of Syracuse, N. Y. Only three connections are necessary for installation; one connection to the cold water line, another to the high pressure



(50 to 150 lb.) steam line, and a third for the hot water outlet. This compact unit which measures only 2½ ft. long by 2 ft. high and weighs less than 100 lb., will replace or supplement indirect heaters and provide a constant supply of hot water for wash rooms, sterilizers, industrial processes, for general cleaning, or as a service water heater booster for high temperature service. Any competent pipe fitter can make the installation. The unit is available in either ½, ¾ or 1 in. steam connections, and with any one of four selected adjustable water temperature ranges. Among the features which distinguish this mixer from equipment heretofore available are the easily accessible clean-out plugs, temperature and pressure relief valves, the single seated steam control valve, sturdy bronze construction, and full vision indicators of temperature, steam and water pressure. Provision for tempering inlet water and recirculating mixer water reduces noise and lime deposit.

Unbreakable Mercury Switches

DURAKOOL, Inc., Elkhart, Ind., announces two radically new mercury switches. One bears catalog No. A-5M; the other No. A-10Z. Both switches have new and novel internal construction



characteristics that enable them to carry substantially greater currents than the regular Durakool Switches with the same dimensions. A standard A-5 Durakool Mercury Switch is rated for 200 watts A.C. lamp load at an operating speed not to exceed 20 times per minute. The A-5M, although having the same physical dimensions as the A-5, has successfully withstood 750,000 operations on a 500 watt A.C. lamp load at an operating speed of 5 times per minute 24 hours a day. It has also taken 50,000 operations on a 1,000 watt D.C. lamp load at a rate of 25 times per minute. The performance of the A-10Z is equally impressive when compared to a standard A-10 Durakool Switch. These two switches are also identical in dimensions. The A-5M has a very small required angular tilt for operation and maintains this angle to a remarkable degree even under heavy overload, and is especially adapted to snap acting mechanisms, as well as tilt action, where it will give a uniform performance. Although priced only slightly higher than the standard Durakool A-5 (5 ampere switch), can be used in a great many applications which formerly required the A-10 (10 ampere switch). Similarly, the A-10Z, at a slight increase in price over the A-10, can be used in very many applications where formerly the capacity of the A-10 itself was not enough and the much larger physical dimensioned A-20 (20 ampere switch) was required.

Plastic Windows

CARBIDE AND CARBON CHEMICALS CORP., New York, N. Y., announce unbreakable windows for many types of control instruments which are now made of "Vinylite" clear plastic sheets. These windows show the operating units of

Tanktrols, automatic water-level controls for elevated tank systems; they cover the accessory depth indicators of Floatrols, used for pump or valve control in connection with open tanks or sumps; they serve as dial windows for depth indicators on Selectrols, complex pump controls for sewage systems; and they permit viewing the switch operation in Duotrols, which automatically control the water level and air volume in pressure tanks.

In service, many of these controls are located in the damp atmospheres of pump houses or over open vats and sumps. Thus the primary requisites of such service are moisture resistance, permanence of form, and transparency. All these characteristics are obtained in Vinylite plastics. The good chemical resistance required in Selectrol operation is also easily attained in these inert thermoplastics. Automatic Control Company is the manufacturer of these controls.

Galvanometer

A NEW GALVANOMETER, more than three times as sensitive as previous galvanometers, has been announced by the General Electric Co. The new instrument is suitable for many applications where wall types were heretofor frequently necessary. Applications include temporary setups for factory and laboratory testing; permanent installations for testing instrumnts, material, and apparatus for production, where rapid readings and minimum fatigue to the operator are essential; and for bridges and other apparatus requiring an external galvanometer.

The extreme sensitivity of this instrument is largely obtained by an arrangement of two fixed mirrors mounted inside the case, one on each end, thus increasing the effective light beam length. This gain in sensitivity is obtained at no sacrifice in sturdiness.

The galvanometer element and optical system are mounted in an attractive case of cast-aluminum alloy. The scale, of translucent compound, is double-marked 50-0-50 and 0-100 in 1-mm divisions. The light source is provided by an automobile-type lamp, easily replaceable, which provides a high-intensity spot with hairline index, so that the scale can be read quickly, accurately, and with minimum eye fatigue. An external adjuster is provided for setting the element on zero. Alnico magnets are employed and the coils are of Formex wire, one of the latest products of G-E research.

New Horsepower Gear Motors

NEW DOUBLE and triple reduction geared motors up to 30 hp. at 91 r.p.m. have been added to the U. S. Syncrogear line made by U. S. Electrical Motors, Inc., 80—34th Street, Brooklyn, N. Y. The larger unit incorporates the pyramidal gear pedestal design which provides ample support to withstand the extra torsional strains and load shocks of geared power. Removal of all internal stress in the castings by normalizing, prevents warping with age and gives permanent alinement of bearings.

Both primary and secondary gears dip in a large oil reservoir in the base to provide ample oil supply to all bearings and gears without submerging any rotating parts.

There will be much that is New at the Power Show

We suggest that all of you who attend the Power Show be sure to see the Reading-Pratt & Cady exhibit. ★ See the 12″ Motor Operated Steel Gate Valve for Main Steam Line Service at 1500-lb. Pressure and 950° Fahrenheit temperature. ★ And see the 6″ Steel Welded Bonnet Gate Valve of unique design for sustained high temperature conditions. ★ You will also see other valves from our line of Bronze and Iron Valves and D'Este Valves and Engineering Specialties. ★ If you do not attend the Power Show, write for details of any of these valves and be sure to get Reading-Pratt & Cady recommendations for every installation.

AMERICAN CHAIN & CABLE COMPANY, Inc.

Indicating Voltage Tester

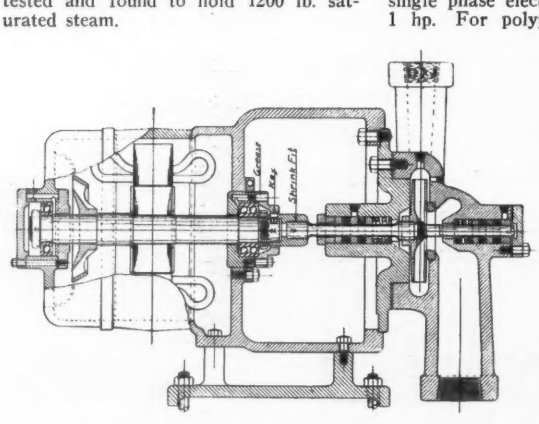
SQUARE D Co., Detroit, Mich., announces several improvements on its Catalog Number 5000 Voltage Tester. This device indicates voltage by the position of the pointer in relation to a graduated scale. The use of different colored bands for each A.C. voltage, together with increased travel of the pointer at the higher voltages, makes possible easier readings. A.C. is distinguished from D.C. by the vibration of the pointer, which is flush with the outside of the case to prevent injury. The operating mechanism has been strengthened and improved to provide even greater accuracy.

The long, rubber-covered lead wires are fitted with hooks and with sharp points for piercing wire insulation without damage. Steel strands in the wires make the leads capable of resisting considerable strain without breaking. Fiber handles insulate the leads which are armored at the entrance to the case to prevent wear or breakage.

Close Coupled Centrifugal Pumps

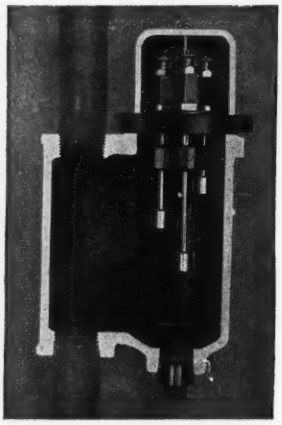
THE CONDENSER CLEANERS MFG. Co., Pittsburgh, Pa., announces a new close coupled centrifugal pump differing from the conventional overhanging shaft construction in that the shaft is separable from the motor shaft and extends through to the impeller through a water lubricated bearing.

It is said that this overcomes vibration of the overhanging shaft and difficulties due to misalinement. All smooth running shafts can be against the pump pressure so as to eliminate a wearing ring on the back of the impeller. The thrust is carried by a double row ball bearing adjustable to regulate the clearance on the suction side of the wearing ring. The packing is said to have been tested and found to hold 1200 lb. saturated steam.



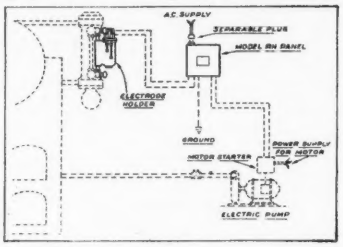
Boiler Water Controls

FOR USE on boiler feed systems where pumps are employed to return condensate or add makeup water, the Johnson Corporation of Three Rivers, Mich., announces two new models of its boiler



water level control, known as Type E, for use with electric pumps, and Type S, for use with steam pumps. They are said to maintain the boiler water at a safe, efficient level by starting boiler feed pumps whenever the water level falls below a predetermined minimum.

Each of the new models utilizes motionless electrode control. Two electrodes, of different lengths, are suspended into a chamber which can be mounted right on the water glass column. When

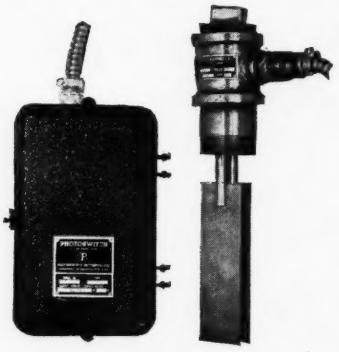


boiler water level falls below the longer electrode an electrical circuit is disturbed which, in turn, through a relay, starts the pump in operation—keeps it pumping until the water in the boiler reaches the short electrode. A third electrode can be provided to shut off the stoker, oil burner or gas burner in the event that the pump fails and the water falls to a dangerous level. Model E will start single phase electric motors as large as 1 hp. For polyphase or larger single phase motors it functions as a pilot circuit to operate a starter. Model S. controls an electric steam supply valve. Normally the steam pump is left to idle at minimum speed until the boiler water level falls below the long electrode, then the control will open the steam supply valve wide — accelerating the pump. This design is said to eliminate all moving parts and floats.

Electronic Level Control

PHOTOSWITCH Electronic Level Control Type P30 at last makes available to industry a simple electronic relay for level control of both conductive and non-conductive fluids and powders. Equipment is available to meet all specifications including single level control, on and off control at two levels, boiler feedwater control, and tank condensate signals. For two-level control, Photoswitch probe fittings or electrodes are attached to the tank at levels representing the low point where pumping starts and high level where pumping stops, and are wired to the Electronic Level Control. When the liquid level falls below the lower probe, the control closes the circuit which starts the pump, and the tank fills, until the level rises to the upper probe, when the fluid itself acts as a conductor of the small amount of current required for the operation of the level control, thus opening the pump control circuit.

Even when used with non-conductive fluids, the probe circuit carries only milliamperes of current, and low voltage, hence, Type P30 can be used with combustibles. It is recommended in connec-



tion with all conductive fluids as well as such insulators as: resin, rubber, latex, paraffin, mica, glass, cement, linseed oil, shellac, mineral oil, wax, waterglass, lacquer, and thinner. Special tank fittings are available for use in corrosive liquids. It is made by Photoswitch Inc., 21 Chestnut St., Cambridge, Mass.

Air Loaded Reducing Valve

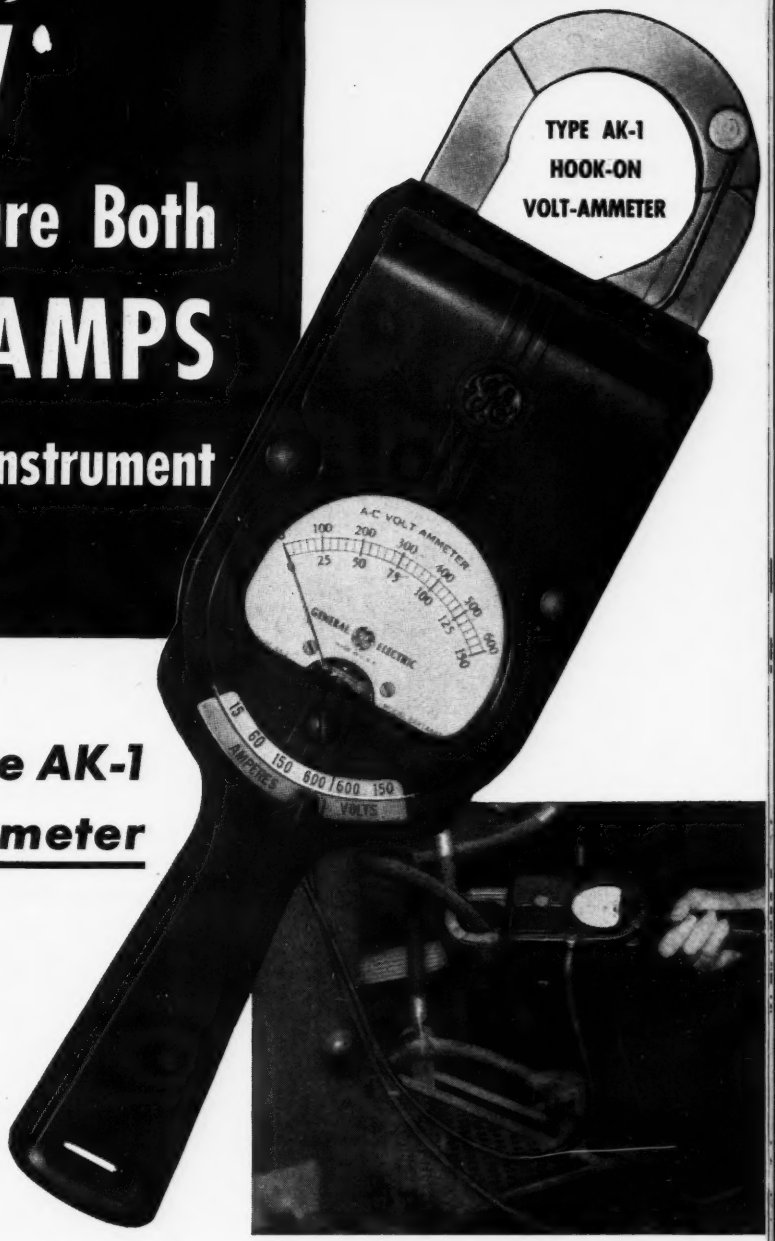
NEW FEATURES in the design of air-loaded reducing valve No. 431, made by Klipfel Mfg. Co., 2641 W. Harrison St., Chicago, Ill., are a stainless steel ball valve, which rotates freely to find its seat, without springing the stem, as it is not attached to the stem; true spherical shape, extreme hardness and self-cleaning action conduce to tight closure and long life.

Internally, a Pitot tube takes the place of an external feeler pipe to cause a slight reduction in pressure above the diaphragm so that with increased demand, the outlet pressure rises slightly to overcome friction loss in the low-pressure line. Water leg is welded steel and air dome of drawn steel.

Standard valves are for inlet pressure up to 250 lb. and reduced pressure from vacuum to nearly initial pressure, in sizes ⅜ in. to 2 in.

NOW

You Can Measure Both VOLTS and AMPS with a "Hook-on" Instrument



That's Why We Call the AK-1 A Hook-on Volt-ammeter

IT'S no trick at all to measure both alternating current and voltage with it. All you do is hook the instrument around the line and read amperes. Then connect the leads to the binding posts and read volts.

No Additional Equipment Needed

You don't need a separate transformer, voltmeter, or any other additional equipment. And you don't need to cut conductors or shut down equipment to make your measurements.

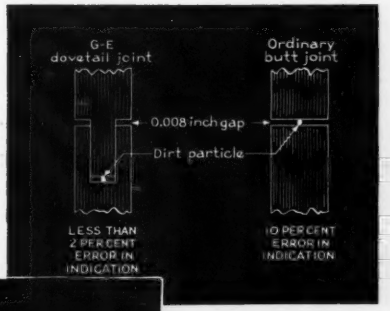
One Setup to Measure Current and Voltage

After measuring voltage, leaving the leads connected does not affect hook-on current readings. Just flick the selector switch to either "Amperes" or "Volts" according to the measurement you want.

Our bulletin GEA-2950 describes the AK-1 in detail, and illustrates how easy it is to use. Order a copy from your nearest G-E Office, or write General Electric, Schenectady, N. Y.

For Emergency and Maintenance Testing

This instrument is particularly handy for quick, accurate measurements when you have trouble with electric equipment and need the answer to circuit conditions in a hurry. Also, you will find it very useful for checking the loading of motors, and for other routine maintenance measurements.


G-E dovetail joint
Ordinary butt joint
0.008 inch gap
Dirt particle
LESS THAN 2 PER CENT ERROR IN INDICATION
10 PER CENT ERROR IN INDICATION

Special Dovetail Joint Assures Consistently Accurate Readings

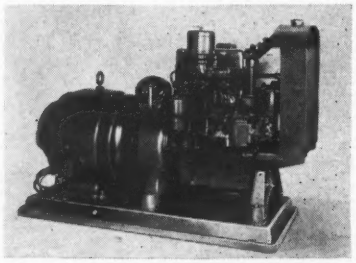
The hook that closes around the conductor has a dovetail joint which minimizes errors caused by unnoticed dirt lodging between the jaws of the instrument. Particles of dirt which would cause large errors in the ordinary butt joint have almost negligible effect on the readings obtained with the AK-1.

GENERAL ELECTRIC

602-15

Diesel Engines

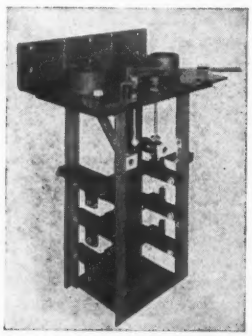
A LINE of small Diesel engines utilizing the Lanova combustion principle has recently been developed by the Atlas-Lanova Div., Atlas Imperial Diesel Engine Co., 1000 19th Ave., Oakland, Calif. These engines all utilize the same cylinder size, 3⅛ in. bore by 3¾ in. stroke and are made in one and three cylinder units with a continuous rating of 5 and 15 hp. respectively, at 1800 r.p.m. Full load fuel consumption runs about 0.45 lb. per horsepower. The engine is supplied in two general designs, an industrial engine which can be supplied with a stub shaft for a straight through drive or a power takeoff for the standard S.A.E. clutch housing.



The same engine made up as an electric generating unit for either a.c. or d.c. comes in 6 models and three sizes; single cylinder, 3 kw., 1800 r.p.m.; 6 kw., 3 cylinder, 1200 r.p.m.; and 9 kw., 3 cylinder, 1800 r.p.m. unit. Standard equipment includes radiators, switchboard, air and oil filters, pressure gage and fuel transfer pump. On the 6 and 9 kw. units standard equipment includes in addition an electric starter, starting switch and water circulating pump.

New Oil-Immersed Disconnecting Switch

RECOGNIZING the demand for a disconnecting switch which can be applied safely in explosives and corrosive atmospheres, the General Electric Company has developed and placed on the market an oil-immersed disconnecting switch. Designated Type SF-1 the device is available as an enclosed triple-pole, single-throw, group-operated disconnecting switch in the 5000-volt, 600-ampere rating. It is for use indoors or



outdoors as an isolating device for oil circuit breakers or motor starters in oil refineries, grain elevators, chemical plants, and similar applications. Applications have already been made at three leading oil refineries.

The new switch has many safety features. All terminals and connections are at least six inches under oil, and double-break contacts with ample clearances are used. The operating lever, which may be locked either open or closed, gives positive indication of switch position. Design of the operating shaft assembly is such that it will withstand more torque than can be applied on the operating lever by one man without the use of an extension lever.

An interlock on the operating lever prevents opening of the switch under short circuit or load. The operating lever is released and the switch may be opened only when an interlock button is depressed. This operation actuates an auxiliary switch in the housing which is connected to trip the starting equipment in the circuit.

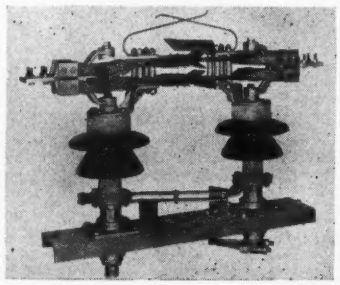
An interlock bar on the tank prevents the removal of the tank with the switch closed or the line side of the switch energized. The tank interlock bar can be removed by unscrewing the plug through the bar only after the switch is opened. The unscrewing of the plug actuates an auxiliary switch which is connected to trip the line circuit breaker. Cable clamps prevent deflection of the cables under short circuit.

Long-life, silver-to-silver, embossed line contacts make maintenance of the new switch negligible. And the location of the operating shaft and interlock plungers in the top of the housing, protected by rain shields, eliminate the possibility of oil leaks. The oil gage is weatherproof.

The tank is finished with a high-quality grade of outdoor paint. Holes for lifting hooks are provided in the top plate, and the switch may be mounted on wall or framework.

Space Saving Switches

SPACE FACTOR is often important, hence, two-insulator horizontal center-break switches are advantageous for group switches. Overall length is small



and short blade permits close phase spacing. This 2000-amp., 23-kv. Type PM-22 switch has both blade portions opening on same side of channel base, causing a combined shearing and twisting action for breaking ice or corrosion. It is manufactured by Delta-Star Electric Co., Chicago, Ill.

Marked Shim Stock

THIN SHIM stock supplied in slotted cartons by Laminated Shim Company, Inc., Glenbrook, Conn., now is furnished plainly marked in inches on its edge, with half-inch subdivisions throughout the 100-inch length. Therefore the metal can be conveniently pulled through the carton slot and cut off to the exact size required. Waste is avoided and the markings act as a telltale signal, indicating when the roll is about used up. These

packaged rolls of brass or steel shim stock (6 in. wide and available in 0.001 to 0.015 in. thicknesses) facilitate shim stock storage, prevent the stock from being mislaid and save time in use. Cut fingers are avoided and handling made easier by the slot-dispensing feature.

Tool Room Lathe

A NEW Series "S" Tool Room Lathe has been announced by the South Bend Lathe Works, South Bend, Ind. This 16-inch swing underneath belt motor driven Precision Lathe is made in 6, 7 and 8 in. bed lengths, having distance between centers of 34, 46 and 58 in. The headstock has 1⅜ in. capacity through the spindle and takes collets up to 1 in. capacity.

The design of this new lathe makes it especially adapted to fine tool room work. A convenient arrangement of controls saves time and effort, reducing operator fatigue and assuring maximum production. Large diameter hand wheels facilitate precision adjustments on close tolerance work. Adjustable micrometer

collars on the cross feed screw and the compound rest screw are large in diameter with clear-cut, easy to read graduations. Tool room attachments supplied with the lathe include hand wheel type draw-in collet chuck, telescopic taper attachment, micrometer carriage stop, thread dial indicator, and chip pan. An electric grinding attachment, milling attachment and other attachments, chucks and accessories are supplied to order.

There's more to POWELL QUALITY than meets the BUYER'S EYE!

Here's a "Big Gun" in Our Own Preparedness Campaign, Making Powell Valves Safe for Severest Temperature Services.

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

What will happen to a metal or alloy when subjected to intense temperature changes is a problem of primary importance when designing valves for extraordinary services. The degree of expansion or contraction which takes place under given conditions has everything to do with the valve's operation, performance, and all-over economy.

One of the many pieces of quality-injecting equipment "behind the scenes" at Powell is this intricate laboratory trouble-shooter, called the Dilatometer. With unfailing accuracy, it obtains critical points of metals when subjected to temperature and determines co-efficients of expansion . . . two vital factors in anticipating the true behavior of Powell Valves when eventually put into service on your property.

It's just one link in a long chain of unseen operations underlying the greater inherent quality of these preferred products, but the Dilatometer is one of the reasons we can say so confidently . . . "there's more to Powell quality than meets the buyer's eye"! Won't you give it a thought next time you're in the market for the best valve performance money can buy?

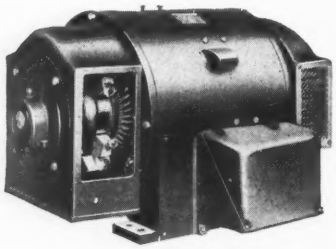
THE WM. POWELL COMPANY
CINCINNATI, OHIO

POWELL VALVES

New Line of D-C Motors

COMPACTNESS and improved protection are two outstanding features of a new line of d-c motors recently announced by General Electric. A new design of rolled-steel frame and improvements in end-shield and bearing-bracket construction combine to give the new motors excellent protection from external damage. The use of Formax wire coils and a specially developed Glyptal insulating varnish provide high resistance to impact, abrasion, and the action of foreign materials. The motors can be furnished with sleeve or ball bearings.

Open motors are available in constant-speed ratings from ½ hp. at 850 r.p.m. up to and including 60 hp. at 1750 r.p.m.; and, in adjustable-speed ratings from ½ hp. at 850/3400 r.p.m. up to and including 15 hp. at 500/1800 r.p.m. Motors in the larger ratings (beginning at 50 hp., 850 r.p.m.) embody additional design innovations such as a new system of self-ventilation, extra protection of all current-carrying and rotating parts,

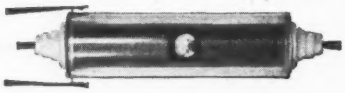


and large conduit boxes. New V-type double-brushholders give better commutation and permit rotation in either direction and a new type lifting lug facilitates handling.

Other features common to the entire line include lower WR^2; small diameter, which means low headroom; reversal without changing any parts of the frame, fan, or brush rigging; and Textolite wedges in the armature slots to protect the windings.

Phasing-Out Voltmeter

A NEW portable 15-kv., high-resistance voltmeter for approximate indications of voltage has been introduced by the General Electric Co. for higher voltages than those now handled by a similar GE 5-kv. voltmeter. Designed particularly for phasing-out power distribution circuits, these instruments are also



suitable for bus sectionalization, location of cable faults, and similar applications.

The new voltmeter is for use on 6900- and 12,000-volt circuits. It has a scale marked 0-15 kv., and is constructed to withstand 30 kv. momentarily since this voltage may be experienced when phasing out 15-kv. circuits. When used for phasing-out service, the instrument will show approximately 0 voltage if the correct phase relationship is obtained, or will go offscale, indicating an improper connection.

Basically, the phasing-out voltmeter consists of a miniature instrument connected in series with a ¼-watt neon lamp and two high-voltage resistors, properly treated to maintain stability under varying atmospheric conditions. A transparent plastic tube completely encloses all of the parts. The indicating instrument used is a rectifier-type milliammeter.

Friction Fighters

REALIZING the difficulties encountered in trying to distinguish between the series numbers assigned to the various types of anti-friction bearing units, Link-Belt Co., Indianapolis, is humanizing the presentation of its five types by comparing them with prize fighters and re-

classifying the group according to the various weights of fighters known to the ring.

The five different types are: Series 100 Ball Bearings, and Series 400, 500, 600, and 7200 self-aligning Roller Bearings.

The new classifications decided upon are Flyweight for the Series 100; Welterweight, Series 400; Middleweight, Series 500; Heavyweight, Series 600; and Alternate Heavyweight, Series 7200.

The whole line of these bearings will be known as Link-Belt "Friction Fighter" bearings, since the term Friction Fighter so aptly describes a characteristic of the anti-friction bearing.

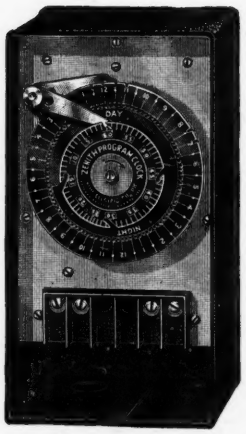
Pyromaster

RECENT developments in Pyromaster Round-Chart Potentiometers and Resistance Thermometers with compact units and simplified operating principle are announced by The Bristol Co., also Bristol Air-Operated Controllers with Free-Vane feature for simple on-and-off control as well as where a large or variable time lag exists, Telemetering Systems, using the Metameter and Metavane are for measuring such values as pressure, temperature, flow, liquid level, motion and electrical power and transmitting to a recorder or controller at any distance.

Program Signal Clock

SYNCHRONOUS Program Clocks for operating time signals are now being manufactured by Zenith Electric Co., 845 South Wabash Ave., Chicago, Illinois, one type to operate a signal at any five minute period, the other to operate a signal at any one minute period.

Pointers, connected to a contact arm, ride the dials and permit the contact arm to fall only when preset time is reached. Units are operated by heavy

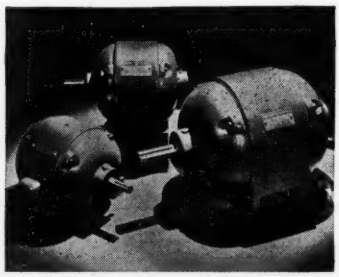


duty synchronous motors, contact being arranged to operate a signal either in one ring or a coded ring, or for a definite duration of time, from 2 to 6 seconds. These clocks can operate for such purposes as daily siren testing, timing industrial processes, and signaling the start and end of operating periods.

Tri-Clad, The New G-E Polyphase Motor

AS A RESULT of a broad survey of the changing requirements of its industrial customers, General Electric announces an entire line of completely new polyphase induction motors, in integral horsepower sizes, to conform with new industrial trends, processes, and practices. Known as the Tri-Clad motor and representing one of the most extensive product changes in the history of the company, it has called for many new methods in G-E motor manufacturing.

In all its ratings it features modern streamlined appearance; more complete protection—through the use of a cast-iron frame—than heretofore available except in especially enclosed machines;



major advances in the insulation of current-carrying parts; and improved bearing design and lubricating arrangements. At the same time, it incorporates the cast-aluminum rotor, pressure-relief system of greasing for ball-bearing motors, and other proven features. In addition, however, it offers many new convenience features.

In recent years there has been an increasing and widespread demand for more protective features in open, general-purpose motors. Thus, despite its striking modern appearance, major industrial interest in the new G-E motor will undoubtedly center around its outstanding mechanical and electrical protective features. In place of the conven-

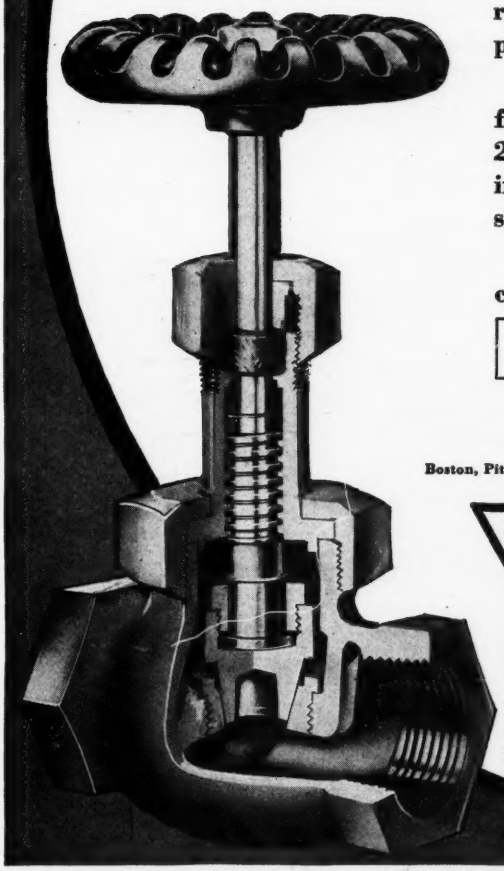
FAIRBANKS

PLUG TYPE VALVES

If you're having trouble keeping valves tight at points where the service is unusually hard, such as for throttling, blow-off, boiler feed or in drain and drip lines, Fairbanks Plug Valves will solve your problem. Seats and discs are made of a special nickel alloy of high Brinell hardness that resists erosion and will not seize or gall.

The wide sealing surface in the seat and disc and the angle of the plug, distribute the stream flow so that it is never concentrated in one position, giving further protection against galling and wire drawing. The plug is ground into its own seat to insure a perfect fit.

Should these parts become worn, they can be replaced easily and quickly, or reground, without removing the body from the pipe line.



Because of their rugged construction and the fact that they will withstand steam pressures up to 225 lbs., these valves can be safely used for most installations, yet they are comparable in price to standard regrinding types.

Write for name of our nearest distributor and catalog No. 21, or mail the coupon.

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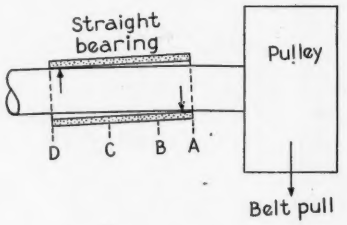
tional open frame, it makes use of a cast-iron frame of the box type. The end shields are designed to match the frame and are enclosed above the centerline. This combination of frame and end shields minimizes contact of vital motor parts with foreign material such as lubricants, coolants, and other liquids, as well as chips, tacks, etc., while also protecting it against accidental blows in handling or similar rough usage. The new-type insulation, dust-tight bearings, and the use of Glyptal in the priming and finishing paints protect against the attack of harmful agents.

In designing the new G-E polyphase induction motors for external appearance, Ray Patten, noted industrial stylist, worked with G-E designers. The external form of any motor is closely interwoven with the provision made in suitable openings for the entrance and exit of cooling air. In the new motor it was determined that these openings should be so located in the end shields and cast frame that there would be a greater degree of protection against the entrance of falling liquid or particles than existed in previous open motors. A goal was set of obtaining the greatest protection of these openings possible without interfering with ventilation. Efforts, therefore, were concentrated on improving the thermal capacity of the motors without reducing the space available for active materials. The use of Formex magnet wire was a long step in the achievement of the desired results. Its excellent insulating properties in addition to its toughness and resistance to heat and

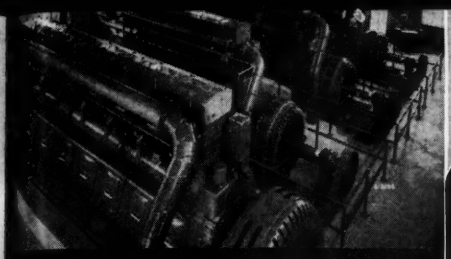


solvents make it an ideal material. Improved air deflectors and fan designs, in addition to double-end ventilation, contributed materially to lower motor temperatures. In the double-end system of ventilation, cool air—drawn into both ends of the motor—immediately impinges against the coil extensions, resulting in equally low temperature of these parts at both ends of the motor. The motor operates well within the standard 40 deg. C temperature rise.

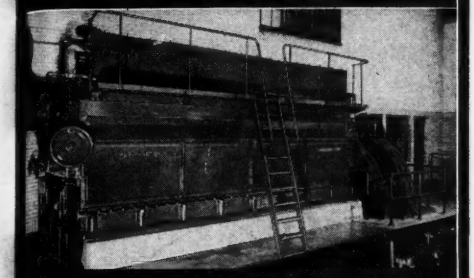
So far as insulation is concerned, the new magnet wire, Formex, is used on all ratings of the new motor. Because Formex is a tough, heat and solvent-resisting magnet wire, it is now possible to eliminate largely the older type paper, cotton coverings, and other fibrous materials which absorb moisture and over a period of years deteriorate due to the effect of heat and chemical agents. Motor windings are further protected by the application of an improved synthetic-resin varnish and a covering coat of Glyptal red. The result is a tough, space-saving motor insulation, highly resistant to heat, moisture, and mechanical abuse.

In evolving the new sleeve bearings, G-E engineers studied the principles long considered as fundamental to sleeve-bearing design and found that basic changes could be made which would, for some

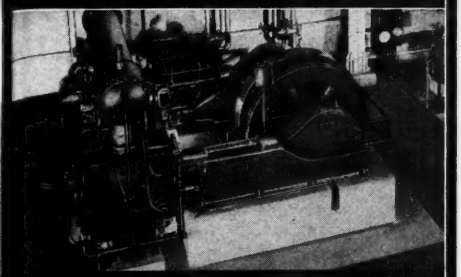
WORTHINGTON



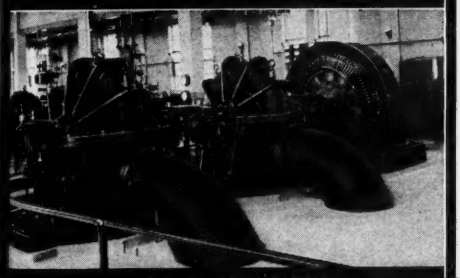
A 2500-horsepower Diesel engine generating plant



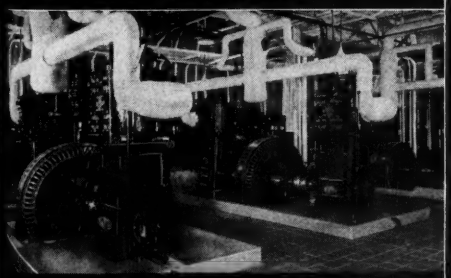
An 800-horsepower gas engine generator unit



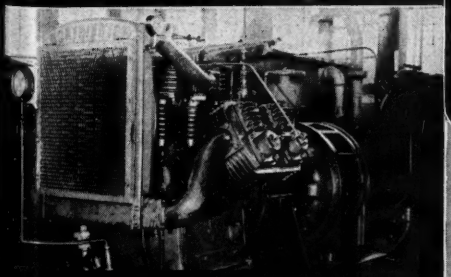
A horizontal duplex compressor for large air requirements



Motor-driven centrifugal waterworks pumps



Vertical refrigeration compressors for air conditioning and ice plants



An angle type compressor for medium air supply

EQUIPMENT *for the* POWER PLANT

DIESEL ENGINES
4-cycle direct-injection and air-injection types.

GAS ENGINES
Horizontal 4-cycle double-acting and vertical 4-cycle single-acting types.

CONVERTIBLE GAS-DIESEL ENGINES
Vertical 4-cycle, readily and quickly convertible for operation on either gas or fuel oil.

STEAM TURBINES
All types, for generator and equipment drives.

SPEED CHANGE GEARS
Reducing and increasing.

STEAM CONDENSERS
Surface, barometric and jet types, for all ranges of capacity. Complete systems with auxiliary pumps, ejectors, etc.

STEAM-JET EJECTORS—(For Vacuum Service)
For moderate to high vacuum. One-stage to four-stage, with pre-condensers, inter-condensers and after-condensers.

VACUUM PUMPS
Rotative Dry Type—Horizontal and vertical; single-stage and two-stage. Electric or steam drive.
Direct-Acting Wet Type—Horizontal single-stage.

FEEDWATER HEATERS AND DE-AERATORS
Open type; for individual requirements.

WATER PURIFICATION EQUIPMENT
Pressure and gravity type filters.

AIR AND GAS COMPRESSORS
Stationary—Horizontal, vertical and angle types, single-stage and multi-stage. All types and sizes. Electric, steam, Diesel engine or gas engine drive.
Portable—Two-stage, air-cooled, all types of mountings. Gasoline, Diesel or electric motor drive.

REFRIGERATING AND AIR CONDITIONING EQUIPMENT
All types, including NH_3, Freon-12, CO_2, etc.; compression, absorption, steam-jet and centrifugal refrigeration.

V-BELT DRIVES—(Multi-V-Drive)
Complete drives, sheaves or belts only.

CENTRIFUGAL PUMPS — HIGH-PRESSURE MULTI-STAGE AND GENERAL SERVICE
For boiler feed, pressure applications, circulating, water supply, sewerage, flood control, other general services.

TURBINE WELL PUMPS
For water supply, drainage, sump, other services.

STEAM PUMPS
All types, horizontal and vertical.

POWER PUMPS
Hydraulic press, boiler feed, varied water services.

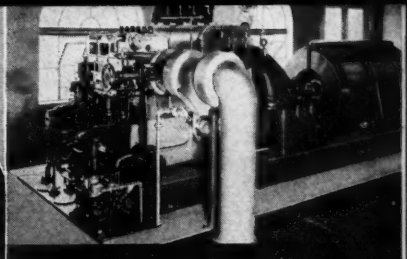
ROTARY PUMPS
For transfer of non-abrasive liquids.

LIQUID METERS
For hot or cold water, chemicals, etc.

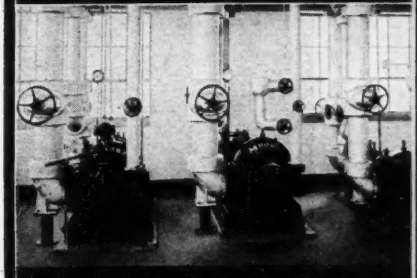
CONSTRUCTION AIR TOOLS
Clay diggers, trench diggers, tampers, pavement breakers, etc.

ICO-50

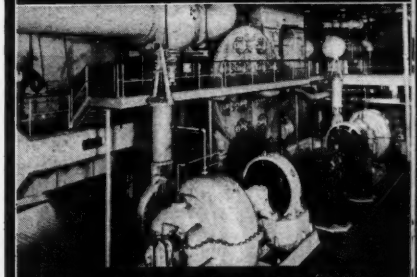
WORTHINGTON PUMP AND MACHINERY CORPORATION
General Offices: **HARRISON, NEW JERSEY**
Offices and Representatives in Principal Cities



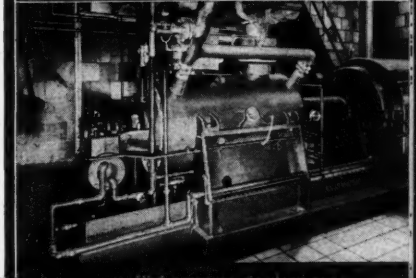
A Moore steam turbine generator unit



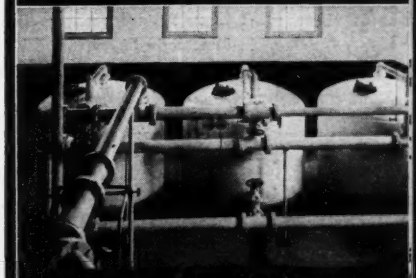
Three Moore turbines driving centrifugal boiler feed pumps



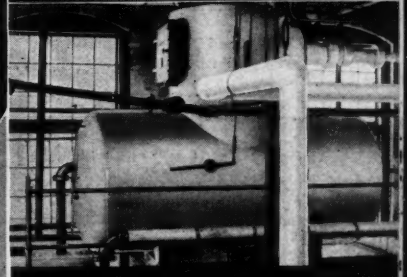
Surface condenser and centrifugal circulating water pumps



High pressure, six-stage centrifugal boiler feed pumps

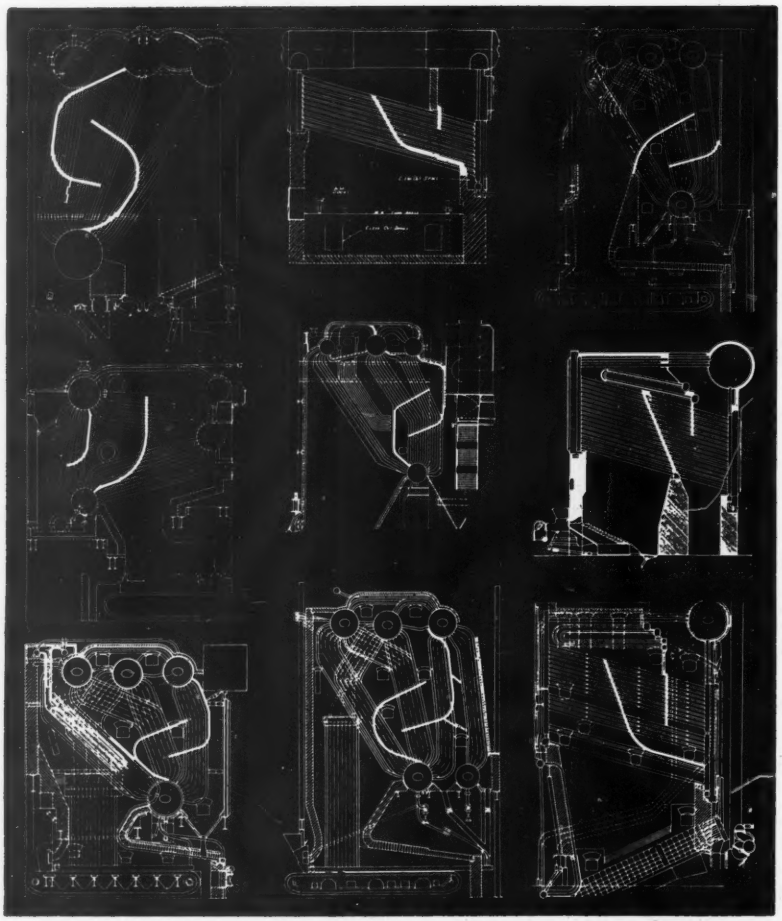


Pressure filters for water purification



An open type deaerating feedwater heater

Enco Streamline Baffles



YOU CAN INCREASE CAPACITY AND EFFICIENCY IN EXISTING OR NEW BOILERS

Installation of ENCO Baffle Walls in all types of water tube boilers has resulted in immediate improvement in performance, operation and maintenance.

Better heat distribution, maximum heat transfer to boiler and superheater surfaces, lower draft loss, lower flue gas temperatures and higher capacity are assured through ENCO design and construction. In addition, the smoothly curved surfaces of ENCO streamlined baffles tend to prevent fly ash and cinder accumulation, saving time and steam by making it easier for soot blowers to do a more thorough and efficient job of keeping heating surfaces clean.

ENCO Baffles, constructed gas tight with Enco Plastic, Tile and Reinforcement provide for expansion and assure extra strength. They may be built in desired locations assuring minimum disturbance when tube renewals are required.

Flexible design, the careful selection of materials and their installation by experienced mechanics result in a construction which can be depended on for long service under severe operating conditions.

TAKE ADVANTAGE OF ENCO SERVICE TO IMPROVE YOUR BOILERS

Send blue prints and operating data and ask ENCO engineers to submit suggestions. No obligation, of course. Ask for the new Enco bulletin BW 40—sent FREE on request and containing detailed engineering information on modern ENCO Baffle walls for all types of water tube boilers. Write for your copy TODAY.

THE ENGINEER COMPANY

75 West St., New York, N. Y.

applications, more than double the capacity of this type bearing. For example, it was discovered that, because of shaft deflections under load, the actual bearing pressures per square inch over the end portion of the lining were much greater than had previously been supposed. Sometimes, because of internal force couples set up in the bearing, this was even aggravated (see drawing). Thus, by using bearings with the proper proportion of length to diameter, the deflections of the shaft inside the bearing can be maintained at a value less than the thickness of the oil film. This, in general, leads to the use of shorter bearings for a given diameter than have been used in the past.

At the same time, it was recognized that maintenance of an oil film over all parts of the bearing linings under loads or as a matter of fact, under any loading condition, is the most important determinant of great bearing capacity and long lining life. The spiral type grooving developed for the new sleeve bearing accomplishes this purpose and gives assurance of thorough oil distribution under the worst operating conditions.

Plastic Packing

THE CRANE Packing Co., 1800 Cuyler Ave., Chicago, Ill., announces a new development in the manufacture of its Super-Seal plastic packing, a patented tape back reinforcement securely vulcanized to the outer surface of the packing. This vulcanized tape reinforcement replaces the old frictional woven cotton jacket and now a non-frictional surface bears directly against the moving part. Due to the tape back reinforcement, this new packing is extremely pliable and can be bent around small diameter rods and

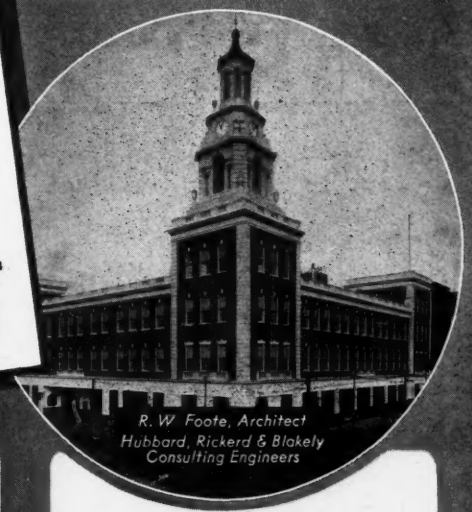
shafts without fracturing or cracking, or formed into small I. D. rings without distortion.

This packing is available in six styles for general and special services: No. 1, for general service—air, water, steam, mild chemicals, etc., where temperatures do not exceed 550 deg. F.; No. 2, for superheated steam, hot oils and hot gases where temperatures run higher than 550 deg. F.; No. 3, for oils, petroleum, distillates and solvents, with temperatures up to 550 deg. F.; No. 4, for foods, fruit juices, and edibles, non-metallic with no graphite and often used on stainless steel; No. 5, non-metallic, for chemicals, caustic alkalies and acids; No. 6, non-metallic, for superheated steam or gases, where temperatures do not exceed 750 deg. F.

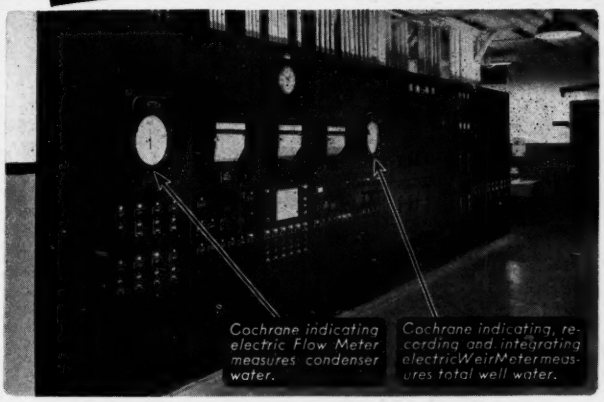
Each type is available in sizes from ¼ to 1 in. graduated by sixteenths, in coils, standard length spirals, die-formed rings, or, sets to stuffing-box dimensions.

COCHRANE *Flow Meters*

MEASURE EFFICIENCY OF LARGE REVERSED REFRIGERATION HEATING PLANT

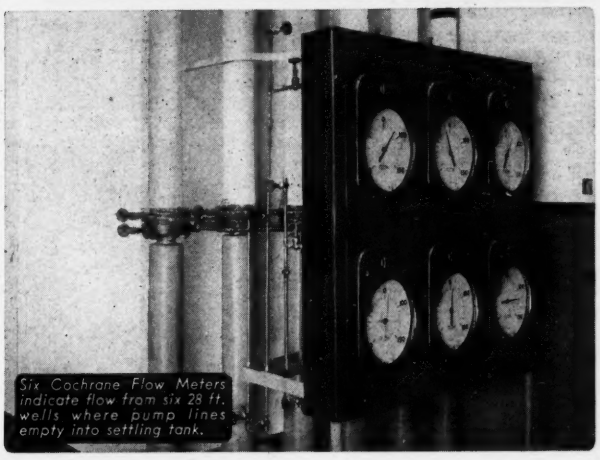


R. W. Foote, Architect
Hubbard, Rickerd & Blakely
Consulting Engineers



Cochrane indicating electric Flow Meter measures condenser water.

Cochrane indicating, recording and integrating electricWeirMetermeasures total well water.



Six Cochrane Flow Meters indicate flow from six 28 ft. wells where pump lines empty into settling tank.

AT UNITED ILLUMINATING COMPANY, NEW HAVEN, CONN.

ONE of the largest and most complete systems of its kind ever installed, the "reversed refrigeration cycle" for heating and air conditioning the new administration and service building of the United Illuminating Co. of New Haven, Conn., is unique in many ways.

By reversing the refrigeration cycle, heating is furnished in winter from the same equipment that provides summer cooling. In the summer, heat is extracted from 55° well water, and the water is then used for cooling. In the winter, the cycle is reversed, the extracted heat being used for heating and the cooled water discarded.

Eight Cochrane Flow Meters measure the flow from the six separate wells, indicate, record and integrate the total well water and measure the condenser water.

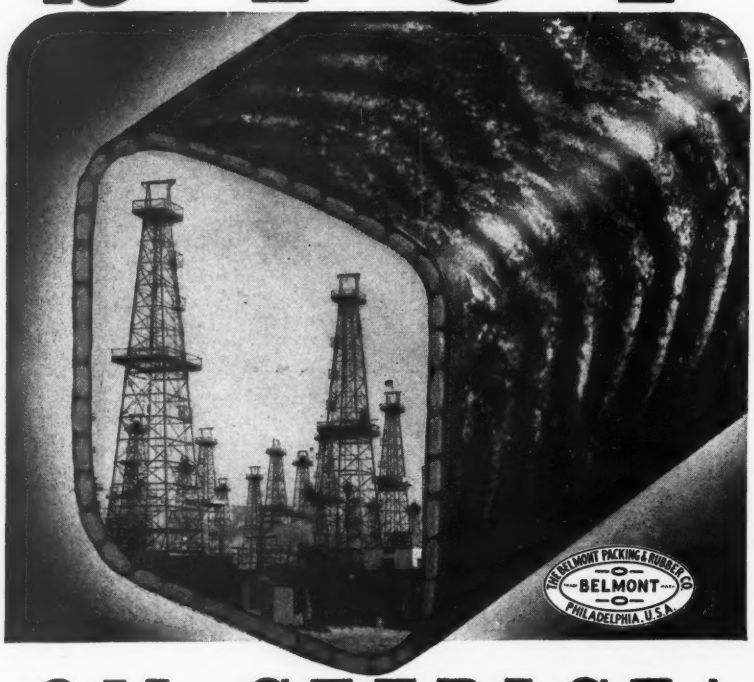
The system is being watched with great interest, and the records of the Cochrane Flow Meters together with other instruments will form the basis upon which its operating efficiency will be evaluated.

COCHRANE CORPORATION • 3123 N. 17th St., Philadelphia, Pa.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

STOP



OIL SEEPAGE!

PACK WITH BELMONT

End that drip drip drip! It's a profit eater —a fire hazard—exposes all your operations to possible loss.

Belmont 6100, illustrated above, is especially designed for use on rods and valve stems handling volatile distillates. Gasoline, naphtha, kerosene and benzol tend to break down ordinary lubricants. But Belmont 6100 uses a *special* lubricant (our exclusive formula) that keeps it soft, retains its sealing qualities longer. The fact that many of the largest refineries use Belmont 6100 is proof that it does the job better.

6100 is just one item in the complete line of Belmont oil packings built to give maximum performance in all types of oil service. Belmont also makes packings for other services. And each Belmont Packing is constructed for ultimate wear and greater efficiency.

The complete line of Belmont Packings (for all types of services) is described in detail in the new FREE 1940 Catalog. Write for it on your company letterhead today!

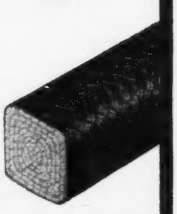
Suggested Belmont Packings For Oil Service

BELMONT 6100

Gasoline Packing. Made of high grade asbestos yarn, braided jacket over jacket. Special lubricating compound keeps packing soft and retains sealing qualities even when applied to volatile distillates. Square cross section. Available in 1, 3 and 5 lb. spools and in sizes from 1/8" to 3/8"

BELMONT 189

Hot Oil Asbestos Packing. Long fibre asbestos yarn, braided jacket over jacket. Oil penetration and saturation minimized by a special formula lubricant. Designed for use on either hot or cold oil rods and plungers. Square cross section. Supplied in packing space sizes from 1/4" up



THERE'S A BELMONT PACKING FOR EVERY SERVICE

BELMONT

PACKINGS

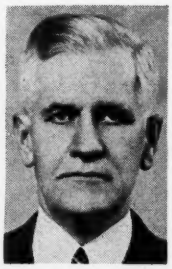
THE BELMONT PACKING & RUBBER COMPANY

BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

News from the Field

Blaw-Knox Appoints Horrell and Gay

S. J. HORRELL has been appointed vice president of the Power Piping Division of Blaw-Knox Co. Mr. Horrell since May, 1939, has been serving this division in the capacity of sales manager, these duties now being increased to include charge of engineering and sales.



Harry Gay

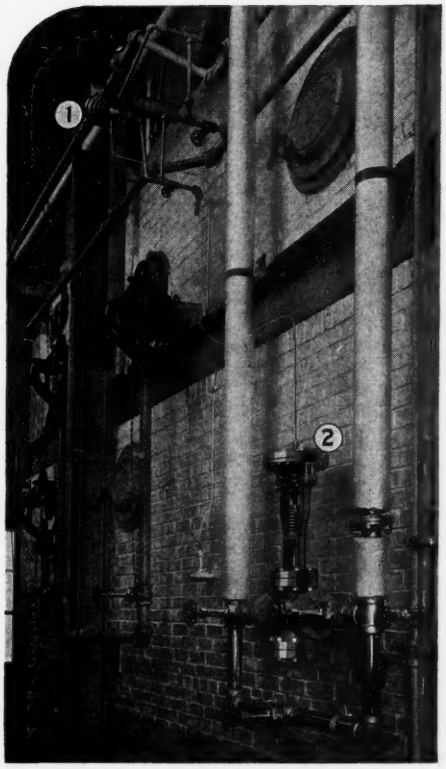
S. J. Horrell

It is also announced that Harry Gay has been appointed chief engineer of the Power Piping Division. Mr. Gay has an extensive experience in paper and pulp processing, power plant engineering and hydraulics with such organizations as Stone & Webster, Sargent & Lundy, Greeley & Hansen, Day & Zimmermann, and Henry C. Ulen.

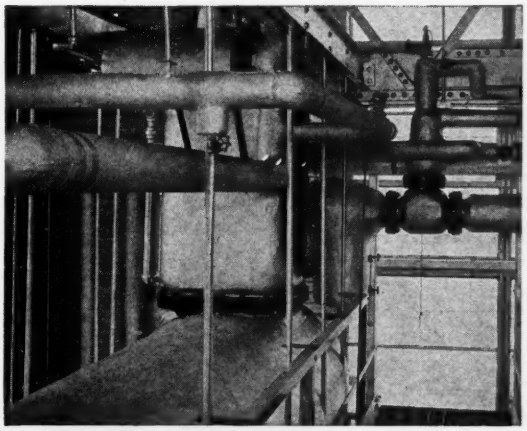
Harold B. Thomas

HAROLD B. THOMAS, one of the founders of the Elastic Stop Nut Corporation, Union, New Jersey, and vice president in charge of sales, has resigned

to enter consulting work in industrial product analysis and market research. He remains active as a director and member of the executive committee of the corporation.

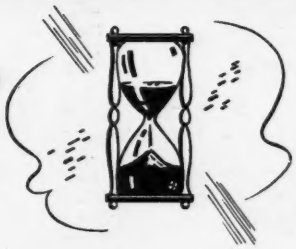


One of the **Type "S-M" Swartwout Feed Water Regulators** *feeding 400 h.p. B&W Type "CD" boilers at Shering Corporation, Union City, N.J.* (1) *— generator, the power element;* (2) *— control valve. Swartwout Feed Water Regulators are easy to install.*



Swartwout Deaerating Heater *mounted on a three foot by ten foot copper bearing steel storage tank at the Shering Corporation plant. Note the rugged construction.*

SAVE



every valuable production minute by smooth sure feed water control

Swartwout Feed Water Regulators and Deaerating Heaters carry a responsibility these days in keeping plants like yours at top capacity — *without losing a minute of valuable production time.*

But full-time operation alone can't achieve largest profits for you if *costs* run out of line. Here's where Swartwout Equipment does double duty in adding to the efficiency of your plant.

Swartwout Feed Water Heaters make greater fuel economy possible — furnish low cost preheating capacity. Their proved ability to remove oxygen and mineral solids from the water means less trouble and expense from scale and corrosion. Sound safe construction assures unfailing trouble-free performance under severe operating conditions.

Swartwout Feed Water Regulators assure correct water supply to busy boilers, protect them from dangers of low water levels, costly accidents. The Swartwout "S-C" principle is simple, dependable, *requires no outside motive force,* permits *wide lee-way* in the location of the two major elements which connect through a single line of flexible tubing. This completely automatic regulation saves time and labor.

Equip your power plant with Swartwout to capitalize on every minute of power demand. In hundreds of plants, "Swartwout" means outstanding worry-free control — recognition of Swartwout's 36 years experience in this field. Write today for Bulletin S-18-D on Heaters; Bulletin S-20-D on Feed Water Regulation.

Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads

Swartwout

•Power Plant Equipment•

THE SWARTWOUT COMPANY
18541 Euclid Avenue • Cleveland, Ohio

* * *

Controlled **AIR CIRCULATION**
for Power Plants and Industrial Buildings

Simplex Type MS

YOU need never guess about the tabulation of Boiler Feed, Turbine Condensate, Steam, Air or other fluids when you have a Simplex Meter on the job.

Although low in first cost and maintenance, and designed for use with orifices, nozzles or venturis—sturdy Simplex Meters provide an accurate summary of fluid flows that pave the way to high savings in plant operation.

There is a Simplex instrument for your specific problems. Let our engineers show you how the proper selection of your metering equipment can insure greater plant efficiencies.

Write for descriptive Bulletin No. 52.

SIMPLEX VALVE AND METER CO.
6790 Upland St., Philadelphia Pa.

SIMPLEX METERS

Reliable Buying Bulletins

In these pages you will find advertisements of firms that make every type of machinery and equipment for generating, distributing and utilizing power. Their messages constantly record latest progress in power plant equipment. They tell you who makes it, who stands behind it. Consider their advertisements as convenient and reliable buying bulletins.

Curtis Heads Timken Division

OFFICIALS of The Timken Roller Bearing Co. recently announced the appointment of George W. Curtis as the Milwaukee Division Manager. Industrial and automotive bearing sales as well as alloy steel sales activities of this division will be under his supervision.

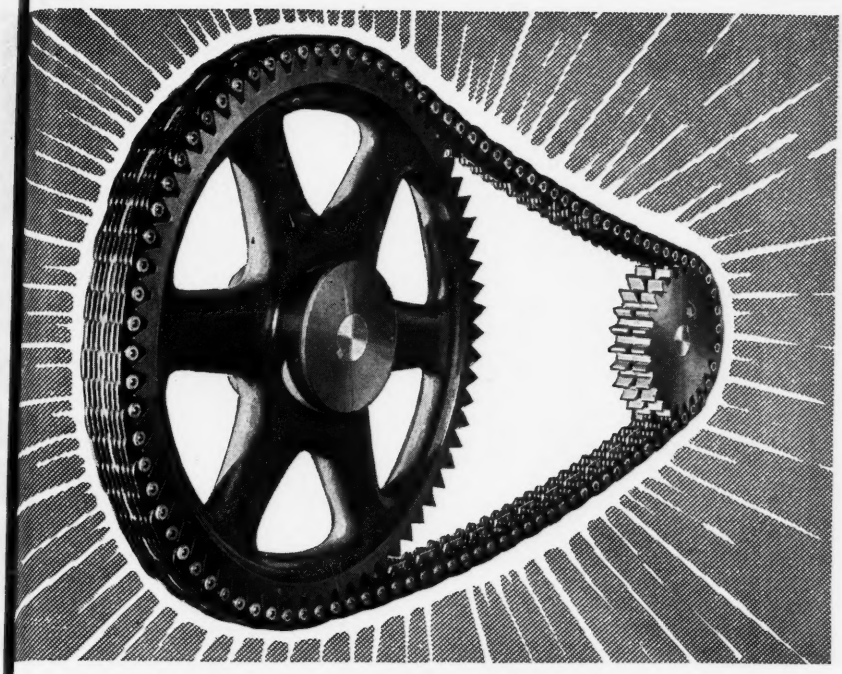
Mr. Curtis graduated from Carnegie Institute of Technology in 1920. After having served in important engineering capacities at Canton, Ohio, and Pittsburgh, Pa., he was transferred to Milwaukee in 1930 where he was made district manager of the Industrial Division. He is widely known for his work in the application of Timken bearings to all types of automotive, agricultural and industrial equipment and also for his contribution to the design of power transmissions.

W. T. Roundy

W. T. ROUNDY has been recently transferred to the Atlanta office of Cutler-Hammer, Inc., Elec. Control Mfrs. As announced by A. C. Gibson, manager of the company's Atlanta district sales territory, Mr. Roundy has been assigned to the state of Florida and will make his headquarters at Orlando. Graduating as an electrical engineer of Marquette University, he began

his career with Cutler-Hammer in the manufacturing division of the company, at the main plant in Milwaukee, Wis. His early experience included work in the testing and inspection departments where he became thoroughly familiar with the design and construction of C-H equipment. He later served in the merchandising and resale sales departments as a sales engineer in the company's Cincinnati and Indianapolis offices.

✓ Try These Efficiency Tests



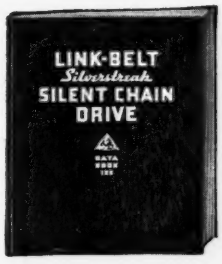
ON YOUR DRIVES

To Cut Production Costs

This Performance ✓ Check-up May Reveal Hidden Profit Opportunities

LINK-BELT Silverstreak SILENT CHAIN DRIVES

• Opportunities to cut production costs by using modern, efficient power transmission equipment, are not always apparent. Losses and waste may continue for years unnoticed and unsuspected, until revealed by a thorough check-up and comparison of methods and results. Here are twelve simple, easy tests for power transmission equipment—twelve important points to be considered. Modern machinery and modern manufacturing methods require modern drives.



96-PAGE DATA BOOK FREE!

Send for Data Book 125. It is an engineering handbook that enables you to determine upon the correct drive and figure its cost. Thousands in use today.

✓ IS THERE LOSS OF POWER THROUGH SLIPPAGE?

If your drives depend upon frictional contact, they waste power through slippage.

Silverstreak Silent Chain Drives cannot slip.

✓ ARE YOU GETTING FULL MACHINE PRODUCTION?

Your machine production is based upon speed of operation, but a drive that slips does not maintain the theoretical ratio from source of power.

Check the rated capacities of your machine with actual production output. There is no guesswork when Link-Belt Silverstreak Silent Chain Drives are used.

✓ IS THE FINISHED PRODUCT UNIFORM?

If your product lacks uniformity, it may be due to slippage.

There can be no slip with positive Silverstreak Silent Chain Drives.

✓ DOES THE DRIVE GIVE CONTINUOUS, UNINTERRUPTED SERVICE?

Are you obliged to make frequent costly adjustments to maintain belt tension?

Silverstreak Silent Chain Drives avoid this condition because they combine flexibility with positive action.

✓ DOES "MACHINE-DOWN TIME" AFFECT YOUR PRODUCTION?

What does "machine-down time" for adjustments and replacements cost you?

Silverstreak Silent Chain Drives last for years, and require practically no attention.

✓ IS INSTALLATION EASILY AND QUICKLY EFFECTED?

Must you dismantle any part of the machine to install a new belt? If so, how often is this necessary and how long is the machine down?

Silverstreak Silent Chain can be quickly and easily installed without dismantling bearings or parts of the machine.

✓ IS SPACE WASTED?

Are your drives compact?

Silverstreak Silent Chain Drives conserve valuable space by operating over small wheels on short centers.

✓ ARE YOUR DRIVES READILY ADAPTABLE TO SPEED CHANGES?

Speed changes are easily accomplished with silent chain drives, by simply changing the diameter of the driver or driven wheel.

✓ DO ATMOSPHERIC CONDITIONS AFFECT YOUR DRIVES?

Is there any difference in the performance of your drives when the atmosphere is hot or cold, dry or damp?

Silverstreak Silent Chain is not affected by atmospheric conditions.

✓ DOES IDLENESS CAUSE DETERIORATION?

Leather and rubber belts deteriorate when not in use. Are you paying this unnecessary penalty?

Silverstreak Silent Chain Drives are constructed of steel throughout. They are not affected by idleness.

✓ HOW LONG DO YOUR DRIVES LAST?

What is the life of your present drives?

A Link-Belt Silverstreak Silent Chain Drive will give uninterrupted service for many years with little or no maintenance.

✓ IS ITS COST LOW—ALL THINGS CONSIDERED?

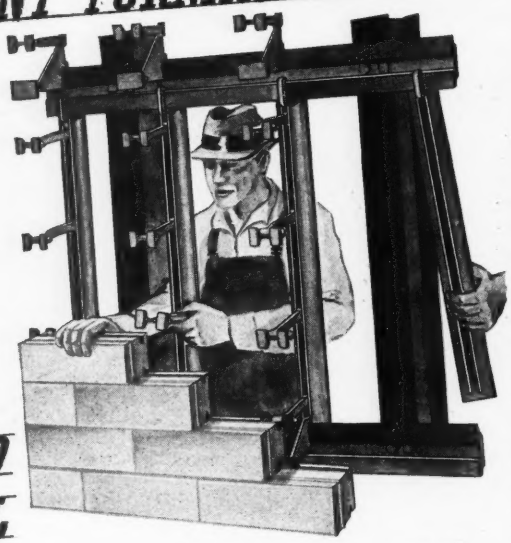
A low-first-cost is not wholly significant—in fact, it may be misleading. Check all the factors—add them up—and compare with cost of Link-Belt Silent Chain Drive—first cost or last cost.

LINK-BELT COMPANY

The Leading Manufacturer of Positive Power Transmitting Equipment

Indianapolis Chicago Philadelphia Atlanta Dallas San Francisco Toronto Offices, Warehouses and Distributors in Principal Citi

PERMANENT FURNACE LINING



EASY TO INSTALL

YOUR ANNUAL FURNACE COSTS may be reduced by this simple, easy to install, Thinsulite wall and arch construction applied to most parts of boilers and industrial furnaces.

Thinsulite consists of 3" or 4½" standard refractory tile supported by heat-resistant castings and backed up with ample insulation. It is a low first cost, permanent, sectionally supported construction.

A saving in labor in addition to the saving in materials helps to reduce the initial cost, and the permanently air-tight and heat-tight construction saves operating costs and shutdowns.

Now you can have the efficiency of an 18" wall in a 6" (overall) Thinsulite wall at a saving in annual costs. Be sure to see the heat transfer curves in the new Thinsulite catalog, sent on request.

Thinsulite WALLS and ARCHES

M. H. DETRICK COMPANY

140 S. DEARBORN ST. CHICAGO, ILLINOIS

Let Us Know About It

If you have a problem on the installation or operation of power equipment, or if we can be helpful in securing latest catalogs or information from manufacturers, let us know about it. There is no charge for this service. Write Reader Service Department, POWER PLANT ENGINEERING.

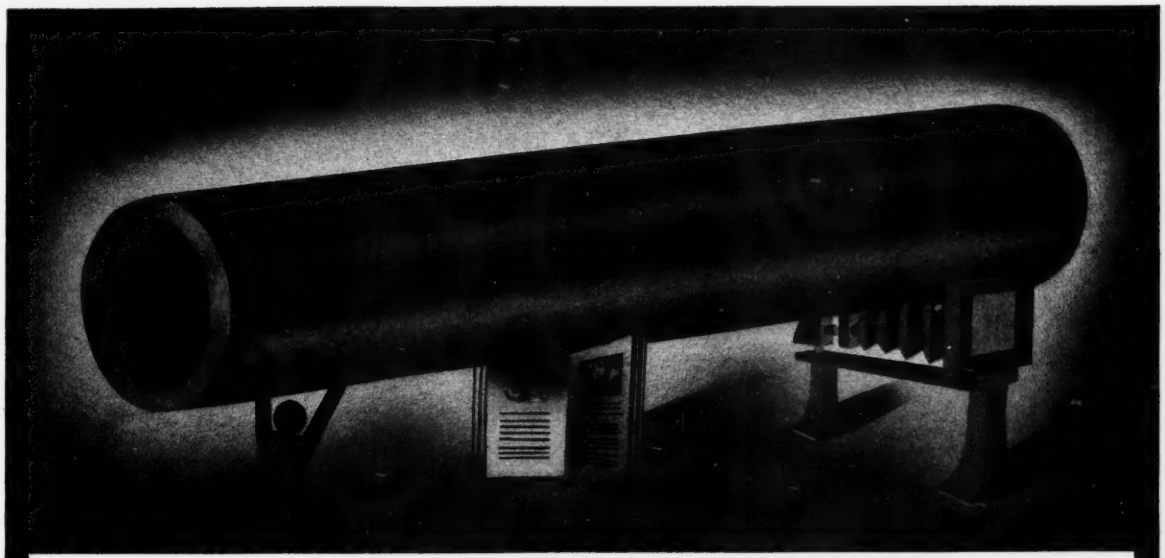
Intended for the exclusive precision manufacturer of Pratt and Whitney aircraft motors, the new Ford plant at Dearborn, Mich. will be windowless and completely air conditioned. Manufacturing operations can be carried on regardless of the outside weather and without detriment to the efficiency of the employees or to the close manufacturing tolerances necessary in this type of work. Refrigeration for the air conditioning will be accomplished by four 1000-t. York-Allis-Chalmers turbo-compressor water cooling systems. This is said to be the largest industrial air conditioning contract ever awarded as a single installation.

General Electric Co. announces plans for a second large building at its Schenectady Works, a brick and steel structure, 560 by 240 ft. wide, for the order and stores department. Offices will be located in a two-story section across the front, the remainder of the building being used for storage. It will be located across the old River Road from the main part of the factory, near the mercury power station. Pile driving for the foundation has already been started, and work on the building itself is expected to be started a week or 10 days after bids are accepted, completion requiring about 5 mo.

Announcement is made of the formation of The McClave Company with main office and works at 936 Hamilton Street, Allentown, Pa. It will be presided over by Robert Brooks McClave, lately president of the McClave Brooks Company. The McClave Company is now in a position to fill orders correctly and promptly with genuine new parts made to the exacting requirements associated with the name McClave for nearly 60 yr. For the New York metropolitan area and Northern New Jersey district offices are at 92 Liberty Street, New York, N. Y. Your inquiries will be given attention by James Beggs & Company, Inc., in the Scranton district territory, comprising Northeastern Pennsylvania and Southern New York state. J. E. Rushmore will be in charge of the company offices located in Scranton, Pa., Post Office Box 146.

Earl G. Morgan, who has been active in air conditioning and refrigeration since 1914, has recently joined Worthington Pump and Machinery Corp., air conditioning and refrigeration division, with headquarters at the corporation's Kansas City, Missouri, office. Mr. Morgan, a member of the American Society of Refrigerating Engineers, served as sales manager of the refrigeration department of the United Iron Works Co., Springfield, Missouri; was connected with the Frick Company at Dallas, Texas; and for 9 yr. was district representative of the Vilter Manufacturing Co., Kansas City.

Blackmer Pump Co., Grand Rapids, Mich., in reorganizing its sales division, has announced, through N. J. Harkness, executive vice-president and general manager, that Bruce P. Hebler, formerly general sales manager is now manager in charge of engineering sales and J. B. Trotman, a newcomer in the organization, is general sales manager in charge of sales and advertising. Mr. Trotman has been for years with Goulds Pumps, Inc., and lately with Roots-Connersville Blower Corp.



Scovill Condenser Tube Service is Supported at 3 Points

insuring more satisfactory operation in your condensers

1 **SERVICE IN METALS**—Scovill laboratories are continually at work on research—developing new alloys and studying various phases of condenser tube installations. Their testing of raw materials and finished tubes insures uniform quality.

2 **SERVICE IN MANUALS** — Scovill's accumulated knowledge of condenser and heat exchanger tube operation is available to customers through booklets like "Condenser Tubes", recently revised. Write us for a free copy.

3 **SERVICE IN MEN** — Scovill engineering representatives study your operating conditions and help you select an alloy best suited to your needs. Then they periodically check the performance of tubes in service, being ready to help when new problems arise.

for any of these three services . . . think of **SCOVILL, "MASTERS OF METAL."**

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL MANUFACTURING COMPANY
17 Mill Street, Waterbury, Connecticut

Please send me the new, revised "Condenser Tube Booklet."

Name .....

Company .....

Street .....

City ..... *State* .....

SCOVILL CONDENSER TUBES **one product . . . three services**

ELIMINATE *fire hazards*

IN COAL STORAGE WITH AN ECONOMICAL SAUERMAN SCRAPER

A 4½ cu. yd. SAUERMAN Scraper handles all the coal required by the Marysville plant of the Detroit Edison Co. Coal is dumped from boats onto cushion pile and is conveyed from there by scraper to main storage pile or to a car loading hopper. Scraper has self propelled tail tower and works over a 300 ft. radius.

A SAUERMAN Scraper incorporates *more safety, economy, and convenience features into one machine than are available with any other type of coal handling equipment.*

Check this statement against these features:

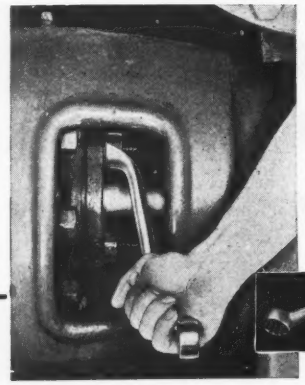
- Stores coal in compact layers, eliminating air pockets that so often cause fires.
- Cost per ton handled into and out of storage is exceedingly low.
- Utilizes maximum storage space of odd-shaped or irregular areas.
- Unit is operated by automatic controls, and the operator is housed in a comfortable control station.
- Maintenance costs are negligible.
- Each scraper is a permanent, trouble-free installation.

Write for Catalog!

SAUERMAN BROS., INC.

486 S. Clinton St. Chicago, Ill.

SEE US AT THE N. Y. POWER SHOW BOOTH 511



TWICE THE SPEED . . . HALF THE EFFORT . . . with Safety-Grip Boxockets

WHEN you're in a hurry, or when you can't get room to swing an ordinary wrench . . . use a Snap-on Boxocket. It lets you apply full leverage with safety . . . and with only 30° handle movement.

When nuts are close together, when bolts protrude . . . use a Snap-on Boxocket . . . its thin-walled head slips in most anywhere, its offset handle passes most any obstruction.

When you need sheer power . . . use a Snap-on Boxocket . . . it grips all 6 corners of the nut, multiplies leverage . . . lets you "put your back into it" — safely . . . without slipping, without damage to the nut. Made in fifteen types, range of wrench sizes 3/16 to 4⅝". Free catalog shows all Boxocket wrenches and 2300 other tools.

SNAP-ON TOOLS CORPORATION
Dept. PPE-12
Kenosha, Wisconsin

Snap-on Wrenches
The Best Tools are the Safest Tools

D. W. Haering & Co., Inc., of Chicago are building a new plant on the Texas Gulf Coast for converting raw materials into intermediate and finished products for water-treating compounds. This $25,000 plant will have storage and shipping facilities for rail and water delivery to points west of the Mississippi River, which will be additional to the present Chicago plant facilities.

This increased activity, with initiation of an extensive research program, has necessitated added laboratory facilities and staff, a new laboratory in San Francisco or Los Angeles being on the way to serve the west coast. Changes in the personnel are George Thompson from the Chicago laboratory to manager of the New York laboratory; Douglas M. Considine, chemical engineer added to the Chicago research staff and O. R. Borngesser to the Wichita laboratory organization; J. R. Lindley and D. R. Walser added to the sales organization and F. H. Wright promoted to manager of district service department in Chicago; C. B. De Lano in Cleveland and H. J. Meacher in Cincinnati added as sales engineers, with Paul Deibner promoted to manager of Ohio district sales; H. D. Van Deman of Tulsa and W. N. Kesler of Oklahoma City going to Wichita sales division, with Arthur Helffenstein added to the Buffalo sales staff and George Wedler to St. Louis sales. Ernest F. Kling takes charge of Detroit and Joseph Babush of Milwaukee district offices.

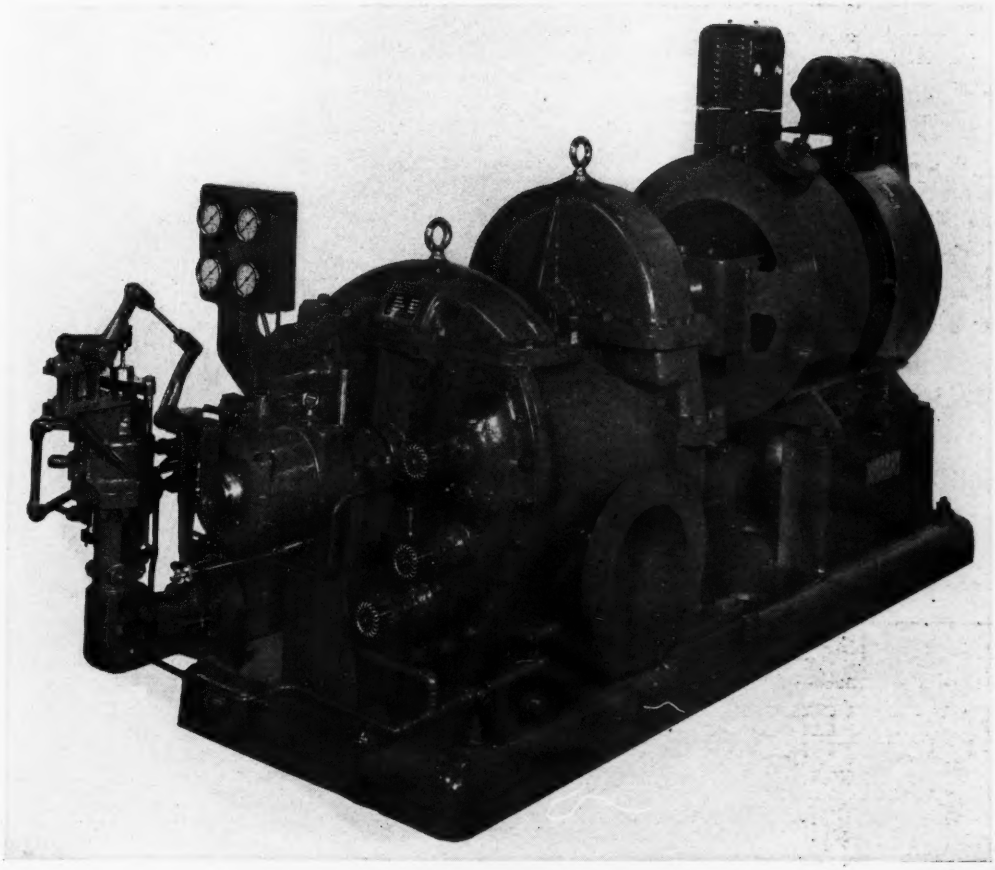
Prevention of sticking of flotation gates which regulate the flow of water at Grand Coulee Dam is to be effected by induction-heated plates, one to each of the 11 gates, placed along the top of the dam. The largest will be 135 ft. long by 8½ ft. wide, with pier plates at each end of each gate, each having 875 sq. ft. Nine miles of heating cable will be used for heating, supplied with 2500 kw. from 22 transformers located in galleries under the gate chambers.

Net sales of Johns-Manville and subsidiary companies for the third quarter of 1940 were $16,408,849, representing a 13.4 per cent increase over sales for the corresponding period last year as reported by Lewis H. Brown, president, recently. Consolidated earnings for the third quarter this year amounted to $1,645,567, compared to a profit of $1,472,255 for the third quarter of 1939. Earnings per share of common stock, after preferred dividends, were $1.80 for the third quarter of 1940 as compared to $1.58 per share for the corresponding period last year.

Joseph H. Lee of New York City has been placed in charge of all lubricant sales east of the Rocky Mountains for Shell Oil Company, Inc., according to a recent announcement by Alexander Fraser, president. Mr. Lee's appointment is part of a move combining Shell's eastern and mid-western marketing and producing units. Executive offices have been centralized in the R. C. A. Bldg., New York City, with twelve division offices in Boston, Albany, Baltimore, New York City, Cleveland, Detroit, Chicago, Minneapolis, St. Louis, Indianapolis, Nashville and Atlanta. Mr. Lee has been with the Shell Company for the past eighteen years.

MURRAY

"Packaged" Turbine Generator Units



Murray "Packaged" Turbine Generating Units are the answer to the problem of moderate electric generating loads demanding economical solution.

These rugged, dependable Murray "Packaged" Turbine Generating Units—

—supply economical electric power
—fit into limited space
—have the generator control at the generator
—eliminate the need for switchboard

The above photograph showing a 100 kw Unit built for an institution is a typical example.

There is a size and type available to meet your requirements.

Have our district representative or home office show you how these Murray "Packaged" Generating Units will save you money.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

WE READ WATER

Every drop of water and every drop of brine has a story to tell us. We know how to read it and answer the many difficulties it is bringing your plant. The story tells a battle against efficiency in your plant . . . corrosion, scaling, too much of this chemical, too little of that. We read it, tell the answer, and have the organic chemicals to correct the water and the brine. Known throughout the Nation are these Haering products . . .

Chrom Glucosates
For Corrosion Prevention

Beta Glucoside
For Scale Prevention

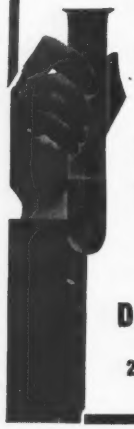
H-O-H Feeders
For Accurate Proportioning

Sodium Glucosate
For pH Adjustment

Sulpho Glucosates
For Oxygen Removal

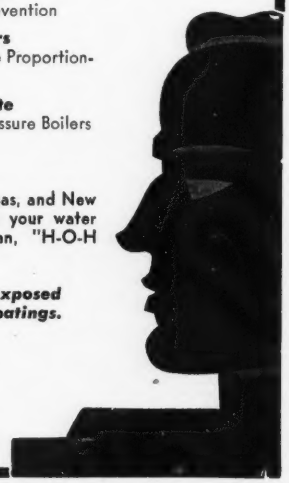
Pyro Glucosate
For High Pressure Boilers

Quachrom Glucosate
For Corrosion Control



Our laboratories in Chicago, Wichita, Kansas, and New York City serve you overnight. Send us your water problems; or write for our house organ, "H-O-H LIGHTHOUSE."

Protect your tanks, pipes and all exposed metal surfaces with In-Hib-Co coatings.



D. W. HAERING & CO., Inc.
Water and Brine Consultants
2308 S. Winchester Ave., Chicago

If You Have a Problem

or if you need information on the construction, use or maintenance of any kind of power equipment, the editorial staff of POWER PLANT ENGINEERING will be glad to help you find a solution or get the desired information. Please give as complete details as possible as to what you want so that the editors may have a clear understanding of your wishes.

Write Reader Service Department, POWER PLANT ENGINEERING.

• •

Important appointments in the Philadelphia Works of the General Electric Co. have been announced by R. V. Good, works manager. These include Robert Paxton, formerly managing engineer of the panel and equipment division, as assistant to the works manager; Harold E. Strang, formerly managing engineer of the large power circuit breaker division, appointed engineer of the Philadelphia works; L. S. Hobson, formerly managing engineer of the small power circuit breaker division, appointed managing engineer of the power circuit breaker division; and George M. Reed, formerly assistant to Mr. Paxton, appointed managing engineer of the panel and equipment division. All appointments were effective as of October 1, 1940.

Additional procurement inspectors are needed at the Air Corps, Wright Field, Dayton, O., for aircraft engines, instruments, parachutes, propellers, tools and gages. For junior inspectors at $1620 a year, college graduation in engineering may take the place of experience as follows: aeronautical engineering for aircraft, engines, instruments and propellers; mechanical engineering for engines, instruments tools and gages, electrical engineering for instruments.

For upper grades, at $2000 to $2600 a year, experience is required in the branch applied for, but for engines, instruments, tools and gages need not be on aircraft, so long as it has involved working to close tolerances, using precision instruments. College courses may replace part of such experience. Applicants will be rated on education and experience, subject to verification, not by written test.

All salaries will be subject to 3½ per cent deduction for retirement annuity. Apply for details to Secretary, Board of U. S. Civil Service Examiners, Wright Field, to any first or second class post office, to Civil Service Commission, Washington, D. C., or to any district office of the commission.

Exports of power-driven, metal-working machinery increased some $1 000,000 or 5 per cent for September over August, the large gain being in milling machines. Some 20 per cent decrease was shown for metal-working machinery not power-driven, and 22 per cent decline for mining, well and pumping equipment. Power-generating machinery showed gain of 9 per cent, internal combustion engines being about the same, but Diesel locomotives being more than doubled, and steam accessory equipment gaining 8 per cent.

Ward Leonard Electric Co. announces the opening of a branch office in Rochester, N. Y. in the Lincoln Alliance Bank Building, 183 Main Street East, with J. K. Savage, sales engineer, as manager.

Expansion program by Johns-Manville to cost $625,000 has been approved by the directors, according to President Lewis H. Brown. This will include installation of manufacturing equipment in the recently acquired plant at Zelienople, Pa., where insulating brick will be manufactured, and the building of new warehouses at the company's plants at Nashua, N. H., and Richmond, Ind.

WHERE THERE'S SMOKE
INDUSTRY IS ON THE MARCH
● When the Nation's stacks fling their smoke banners to the skies we know industry is producing. And in thousands of boiler furnaces under these stacks we know that "Carbofrax," the Carborundum Brand Silicon Carbide Refractory, is insuring uninterrupted production and greater production.
Every square foot of grate area is at a premium these days ... keep them open. Every forced shut down is a near disaster ... eliminate them.
"Carbofrax" brick along the clinker lines are improving combustion conditions ... maintaining fully effective grate area because clinker does not build out from them and steam production is kept at a maximum ... eliminating frequent shut downs due to lining failures, thereby reducing interruptions to production.
"Carbofrax" brick insures these benefits because of their high refractoriness, high resistance to abrasion, softening and spalling.
Let us give you the complete story of why a "Carbofrax" setting is always a dependable setting.
CARBORUNDUM
Refractory Division
THE CARBORUNDUM COMPANY
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PERTH AMBOY, N. J.
District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh.
Distributors: McConnell Sales and Engineering Corporation, Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles, San Francisco, Calif.; Denver Fire Clay Co., El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.
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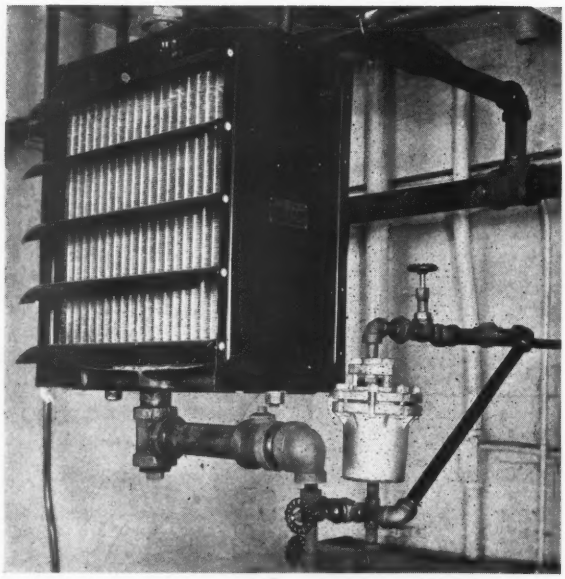
K-MASTER

INVERTED BUCKET STEAM TRAP



TRAPPING STEAM on a Unit Heater in a Food Products plant with many K-Masters

This picture is a particularly good one because it shows so well the external valve assembly—even the bronze valve body between the cap and cover.

This external valve assembly in the K-Master is the first thing that catches the eye of those who make it a point to compare traps. It's one of the features that keeps them so sold on the K-Masters, once they have tried them, that they come back for more and more as did this food products plant.

Summing up, K-Master features include:

1—reversible valve and seat, thus giving double life.
2—external valve assembly with no gaskets, pins or threads, reducing time of inspection and valve reversing.
3—self-tightening joints in valve assembly.
4—self-cleaning vent (if desired) for dirty lines.
5—thermo float (if desired) for venting large quantities of air or gas.

Why not place an order *today* for a trial K-Master? Prove its superiority for yourself.

Thousands of K-Master Traps are giving efficient service in hundreds of plants.

Exhibiting in Booth No. 253 at the New York Power Show

KAYE & MACDONALD, INC.

92 Franklin Avenue West Orange, N. J.

An expenditure of approximately $11,000,000 has been announced by the DuPont Company for a second nylon yarn plant to come into production late in 1941 and be in full operation by the spring of 1942. This unit will be built at Martinsville, Va., and will employ about 750 people when completed.

The first nylon unit at Seaford, Del., began shipping nylon early in 1940 and is now turning out yarn at the rate of about 4,000,000 lb. a year. A second unit at Seaford is just going into operation, will reach full production by midsummer next year and will double the initial capacity there. When fully completed the two plants will have an aggregate capacity of approximately 16,000,000 lb. annually.

Robins Conveying Belt Co., Passaic, N. J., has completed the reorganization of its Advertising Department, H. Von Thaden, vice-president and sales manager of the company, announces the appointment of Alfred S. Otton as advertising manager, assisted in his new duties by E. E. Riches and John M. Lupton. Mr. Otton has been associated with the Robins Co. since 1937, having recently been in charge of all screen cloth sales. Mr. Riches has been connected with both the Engineering and Preliminary Design Departments for many years. Mr. Lupton comes to the company with a wide background of experience in advertising and printing.

Harry L. Williamson, formerly assistant manager of cable sales for the General Electric Co., was appointed, as of November 1, manager of sales promotion for the Locke Insulator Corp., of Baltimore, Md., a G-E affiliate, according to an announcement by R. G. Bellezza, president of the insulator firm. Mr. Williamson has been associated directly with General Electric since September, 1928, in testing, central station apparatus and cables. A native of Nashville, he graduated from Vanderbilt University with a B.S. degree in Electrical Engineering in 1928.

Twenty lightning strokes on the Empire State Bldg. in New York City have been recorded during the past summer, with no harm to the building. Eighteen of the oscillograph records were secured. The study has been carried on since 1935 with record of 1 to 41 strokes in a season. The study is in connection with lightning protection from power lines.

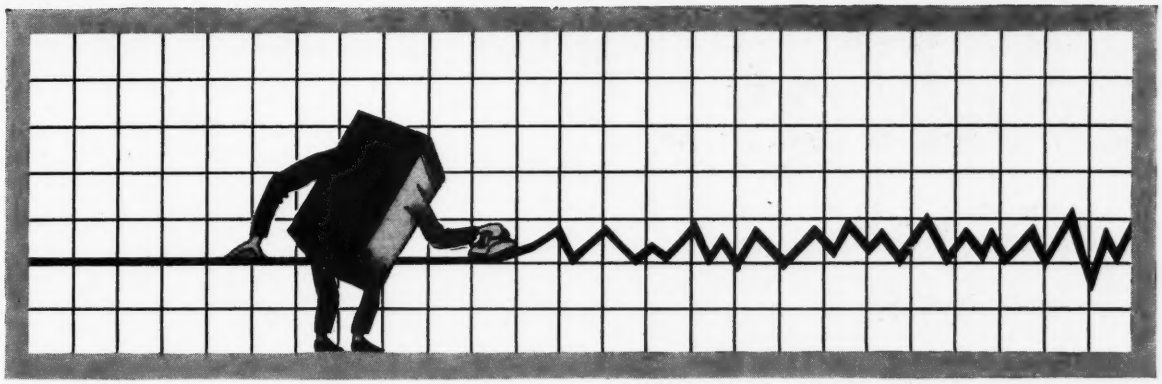
Natahala Power & Light Co., Franklin N. C., is planning hydro electric development in the Little Tenneessee River, to be known as the Fontana Project, consisting of a dam 470 ft. high for storage of 1,000 000 acre feet and power plant of 300,000 hp. Power is to be sold to the public, and to an affiliated company for manufacture of aluminum. Federal Power Commission has acted favorably on the application for license to construct the development.

Henry H. Timken, Jr., has been named Chairman of the Board of The Timken Roller Bearing Co., succeeding his father, the late Henry H. Timken, Sr., and will continue as Vice-president and General Manager of the Steel and Tube Division of The Timken Roller Bearing Co. Mr. Timken has been associated with the company since his graduation from Harvard and has been a director for 10 yr. John E. Fick, Superintendent of the Steel Mill, who has been affiliated with the Timken Co. for more than 20 yr., has been added to the Board.

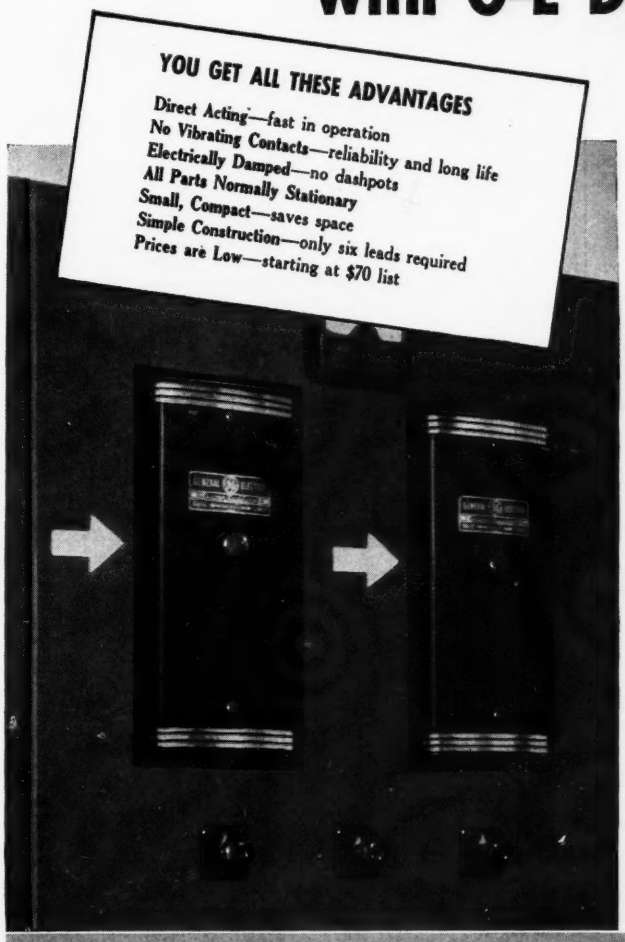
For the 465,000-kw. Charles R. Huntley steam station of Buffalo Niagara Electric Corp., near Tonawanda, N. Y., an 80,000-kw. turbine-generator has been ordered from the General Electric Co. as part of an expansion for this station, which will involve a total expenditure of $6,000,000 to take care of future power requirements of the area.

General construction of the building to house the plant will get under way as soon as final plans are completed. The new addition will be ready to deliver power within two years.

Among subjects to be discussed at the N. Y. meeting of the American Society of Refrigerating Engineers, Hotel Commodore, Dec. 3 to 5, will be: Freezing of Meats, Air Conditioning Operation, Personnel Problems in the defense program, Aluminum in Refrigerating Equipment, Vibration Isolation, Heat Interchangers, High Humidity in Commercial Refrigerators. A smoker will be held for new members at 4:30 p. m., Dec. 3, an inspection trip to the North Beach-Airport with luncheon at the restaurant Wednesday afernoon, and a dinner dance at Hotel Commodore in the evening.



Iron Out Your Voltage Bumps with G-E DIACTOR Regulators


YOU GET ALL THESE ADVANTAGES
Direct Acting—fast in operation
No Vibrating Contacts—reliability and long life
Electrically Damped—no dashpots
All Parts Normally Stationary
Small, Compact—saves space
Simple Construction—only six leads required
Prices are Low—starting at $70 list

VOLTAGE bumps and dips are "easy meat" for this little fellow. Once you put him on the job, you can be sure of a smooth voltage curve—he'll keep it that way.

Here's what he does: He holds the normal voltage close to the desired value without hunting or instability. After a change in operating conditions, he quickly returns the voltage to normal. And, because of the simple, reliable design, you are not troubled with bothersome, costly maintenance.

The G-E Diactor generator regulator has a quick-action, wide-range rheostatic element that provides an infinite number of smooth resistance steps from practically zero to the maximum.

What's YOUR Voltage Problem?

Do you have a generator voltage-regulation problem that involves a new installation? Are you replacing old regulating equipment? Do you have machines already in service that need some provision for adequate regulation? Whatever your requirements, there is a Diactor generator regulator exactly suited.

For complete information, just drop a note in the mail or call the G-E office near you. We'll be glad to send you Bulletin GEA-2022, or have a specialist call to discuss your voltage-regulation problems at your convenience. General Electric, Schenectady, N. Y.

Section of switchboard panel showing how well the modern streamlined Diactor regulator is adapted for semiflush mounting

GENERAL ELECTRIC

352-3

WATCH A DART GET ITS "SECOND WIND"

Dart Unions consistently get off to a good start, make up tight quickly, stay tight unfailingly. But the most important ability of Darts shows up best in the long run: Take down a Dart, *re*-install it, and you'll find it holds the same stride, assures the same dependable tightness as the first time installed. . . . It's just plain, common-sense economy to take advantage of Darts *repeated-use*. It assures you lower cost-per-tight-joint. So next time you change or add piping, use Darts and save.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

For The Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Controls, Regulators and Gages

Controls—Maintenance of any steam temperature and pressure desired, by the Brown reducing valve desuperheater control system is illustrated in catalog 29-31 issued by Brown Instrument Co.

Control—Specialties are described in Leslie's new complete catalog, Series 400. Included among the specialties are: Pressure reducing valves for air and steam service; pressure controllers with diaphragm regulating valves; pump governors; temperature regulators; self-cleaning strainers. The catalog also includes a section on reference tables and data. The Leslie Co.

Control—The Visaflame control system, actuated by light, and applicable to oil or pulverizer coal burners to provide protection against flame failure or current interruption is described in two new bulletins, Bulletin V-4, 8 pages, covers the application for manually operated industrial oil or powdered coal burners. Bulletin V-6, 8 pages, covers the application to smaller domestic oil burners. Both bulletins describe the operating principle of the device, its application and mounting to different installations, control wiring diagram and operating instructions. The Mercoid Corp.

Control—Canton Synchronized Control is the title of a new 4-pp. bulletin outlining the advantages and construction of the new Canton Automatic variable speed stoker and draft combustion control, applicable to from one to five boilers and incorporating a special "holdfire" control for night or standby service. Canton Stoker Corp.

Regulators—To show the scope of Askania Automatic regulation, the Askania Regulator Co. has published a 12-page illustrated book entitled "Evidence," which is filled with installation views, showing how the Askania jet pipe regulator is used to control furnaces in the iron and steel industry, in power plants, glass melting tanks and process plants. The Askania Regulator Co.

Flow Meters—Schematic diagrams for the measurement and control of steam, air, oil, water, chemicals and other fluids for Brown Electric, High-Pressure, Low-Pressure and Area Meter Bodies are being issued. These include piping layouts and special design features. Brown Instrument Co.

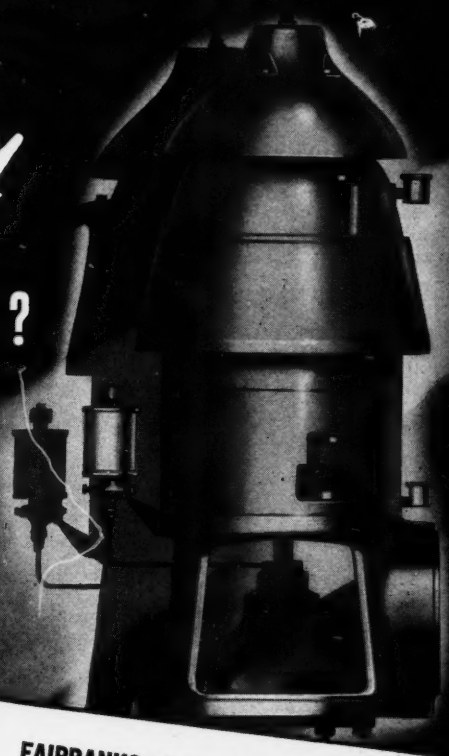
Gages—A new catalog No. 6706 on Rectangular Case Thermometers and Pressure Gauges covers the complete line of Brown vapor-actuated, gas-actuated, mercury-actuated and portable thermometers for indicating, recording and controlling processing operations, and details the powerful flat spiral actuating elements, overload safeguard. Brown Instrument Co.

Boilers and Compressors

Boilers—The Frederick Steam Generating Units is a 4-pp. catalog illustrating and describing a new line of shop assembled units built in standard sizes ranging from 6500 to 25,000 lb. of steam per hr. Union Boiler & Mfg. Co.

Blowers—A new bulletin, 21-B-35, describes the Victor-Acme rotary positive blowers for handling small and medium volumes of air against pressure or under suction, ranging from 8 oz. to 7 lb. per sq. in. The bulletin also contains a table of ratings of the several different sizes of blowers and illustrations of the blowers in the numerous arrangements in which they are furnished. Roots-Connersville Blower Corp.

Conspiracy IN YOUR PLANT?



FAIRBANKS-MORSE TURBINE PUMPS

Complete range of capacities (35 g.p.m. to 4000 g.p.m.) for electric motor, Diesel or gasoline engine, or steam turbine drive. Open or closed impellers, oil or water lubrication. Today's 6" F-M Turbine is *23% more efficient* than the same size was in 1927; today's 10" turbine is 21% more efficient than the 10" pump was in 1927!

YES, a conspiracy between a pump and the power meter!

A conspiracy that can—and DOES—go on unnoticed year after year in hundreds of plants where old pumps are imposing a 10% "penalty tax" on the operating budget? That *is* happening in your plant—if your pumps are old. Due to improved methods, improved materials, and improved design, today's Fairbanks-Morse Pumps are at least 10% more efficient than the same types were ten years ago. Thus, if your old pump is as good as new (it probably isn't), it is costing you at least 10% more to operate it than it would cost to operate a new one. *10% is a good return on any kind of investment!*

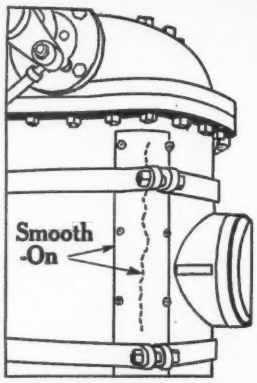
It won't cost you anything to find out how much new pumps would save you. Write Fairbanks, Morse & Co., Dept. 83, 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the United States and Canada.

7857-PA40.70

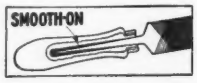
FAIRBANKS · MORSE PUMPS

DIESEL ENGINES ELECTRICAL MACHINERY RAILROAD EQUIPMENT WASHERS-IRONERS STOKERS
MOTORS FAIRBANKS SCALES WATER SYSTEMS FARM EQUIPMENT AIR CONDITIONERS

From a cracked machine casting to a loose tool handle



dozens of plant repairs can be made with Smooth-On No. 1



The money-saving uses of Smooth-On are almost endless. This many-purpose iron repair cement will seal cracks in casings of boilers, heaters, pumps, valves, piping and machinery parts, will stop leaks at pipe connections, seams, bolts, rivets, screws, etc., and will tighten loose fixtures and parts of equipment all over the plant.

Smooth-On has been doing these jobs successfully for 45 years, as thousands of engineers can testify. It is easy to apply, requires no heat, special tools, nor previous experience, hardens quickly, becomes stronger with age, and makes a lasting repair.

FREE 40-Page Handbook

Every engineer should have a copy of this useful repair manual, with 170 diagrams and simple instructions for ingenious, practical short-cuts in emergency repairs and routine maintenance jobs. Much of the information in this handbook is unobtainable in any other publication, and will help you save time and labor on innumerable jobs. Your copy sent free if you mail the coupon.

Buy Smooth-On No. 1 in 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house or if necessary, from us.

For your protection, insist on Smooth-On — used by engineers since 1895.

SMOOTH-ON MFG. CO., Dept. 31.
570 Communipaw Ave., Jersey City, N. J.
Please send SMOOTH-ON HANDBOOK.
Name .....
Address .....
12-40 .....

Do it with **SMOOTH-ON**

Air Compressors—Bulletins on Worthington air compressors recently received, cover: Small compressors of 1 to 164 cu. ft. per min. for 20 to 1000 lb. pressure, Bulletin H-620-M11; Portable Gasoline Engine-Driven Compressors for 60 to 315 c.f.m., Bulletin H-850-B52B; Refrigeration Compressors 5 by 5 in. and smaller, Bulletin C-1100-B11. Worthington Pump & Machinery Corp.

Compressors—Air and Gas Compressors of the horizontal-duplex motor driven type are fully illustrated and described in Bulletin No. 726, second edition. The special features of design incorporated in these compressors include Simplate valves, 3-step and 5-step control, automatic starting unloader, effective intercooler design, flood lubrication of bearings, and wedge adjustment for all bearings. The Chicago Pneumatic Tool Co.

Electrical Equipment

Voltmeters, Switches, Instruments—Bulletin GEA-3020A describes Electrostatic Voltmeters in sizes for 3 to 20 kw., shielded in an aluminum case for detecting static charges and making insulation tests. Bulletin GEA-2753 is on Instruments and Time Switches for current and voltage measurement and recording time measurement, and automatic control of circuits, for a periodic or cyclical operation. General Electric Co.

Capacitors—Capacitor application on distribution circuits is the theme of a 28-pp. booklet intended as a permanent reference manual for electrical engineers. Containing theory, formulas, tables, and charts, the new booklet tells how and where to apply capacitors when voltage drop is the controlling factor and where higher power factor is the requirement. Complete discussions of fundamentals, costs, sizes, locations, and other elements of application make this booklet in reality a textbook of capacitor application. Effects of capacitors on telephone interference, and on wave form are explained. It is not a catalog and contains no capacitor listings, but copies of Application Data 49-065 may be obtained upon request. Dept. 7-N-20, Westinghouse Electric & Mfg. Co.

Metals

Metals—Brief Facts About Ampco Metal is the title of a 16 pp. catalog recently released covering this metal. Six grades and modifications of metal are described, and illustrated by photomicrographs. Special emphasis is made upon the control and process of producing aluminum bronze metal and Rotocasting said to be an improved centrifugal shape casting method. Ampco Metal, Inc.

Weld Metal—Ampco Weld, a new coated aluminum bronze electrode with the properties of Ampco Metal and made in six grades ranging from soft to extremely hard, is described in a new 8-pp. catalog. This material is particularly applicable for rebuilding worn cams, gears, dies and bearing surfaces or for new work where bearing properties to corrosion resistance can be used to advantage. Ampco Metal, Inc.

Nickel Alloys—Bulletin T-2 is a recent 32-page bulletin covering welding, brazing and soft soldering of Monel, nickel and Inconel. The booklet is in the nature of a service bulletin for designers of equipment using these alloys and for the welders who might do the job. Development and Research Division, The International Nickel Co., Inc.

Refractories, Mortars and Fire Bricks

Refractories and Mortars—Three new bulletins on H-W products have recently been issued. High Temperature Bonding Mortars is a 16-pp. catalog in color covering characteristics and applications of Harwaco, Thermolith and Firebond mortars. Acid-Proof Brick and Tile is a 6-pp. folder on Duro Refractories, adapted for temperatures as high as 2400 deg. F. for industrial applications in conjunction with nascent gases and acid fumes. H-W Coleman Fire Brick is a 4-pp. folder announcing the continued manufacture of Coleman fire clay brick taken over on April 1 from the Athens Brick and Tile Co., Athens, Texas. Harbison-Walker Refractories Co.

Refractories—Super Refractories by Carborundum has just appeared discussing in 76 pages the properties and applications of the company's brands, including silicon carbide, fused aluminum oxide, mullite and aluminum silicate. Included are Carbofrax brick of various shapes, also cements, Alfrax special shapes and cements, Mullfrax brick and shapes, Firefrax cements. The Carborundum Co.

YOU NEED INVEST ONLY $98.00 THE SIMPLE CASH STANDARD WAY TO GET A START ON THE MANY BENEFITS OF AUTOMATIC COMBUSTION CONTROL

To begin with, you pay $98.00 — that is all — for the Furnace Draft Controller which you install first with the thought that later on, when you are ready, you can add enough additional units to have a complete CASH STANDARD Automatic Combustion Control System. This purchase plan, which is being used and appreciated by many companies, saves the need of a large initial investment.

The way you can prove that this equipment is tops in quality and in performance is to try it—and it only costs $98.00 to start, yet you get the immediate benefits.

These control units are precisely the same as those we furnish on the most elaborate jobs—and for the largest kind of boilers. To make this plan workable, the simple requirement is that the control units be installed conveniently near the apparatus they operate without panel board.

You get a Fuel Feed Controller, Air Flow Controller, each with an Operating Power Cylinder and some simple connecting fittings—all for as little as $300.00. If you want CASH STANDARD Control Systems on panel boards, you can get them but we emphasize that the control units work just as well mounted individually elsewhere.

FURNACE DRAFT CONTROLLER — A

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper, to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the two Controllers B and C shown in illustration. It does its part toward money-saving by eliminating wasteful air infiltration.

FUEL FEED CONTROLLER — B

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

AIR FLOW CONTROLLER — C

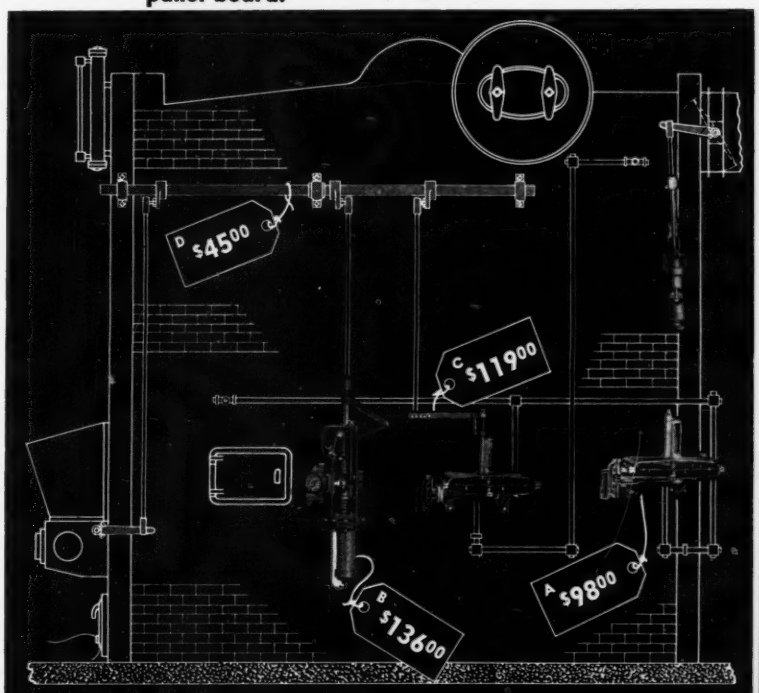
This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

OIL CIRCULATOR

All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate this equipment with this CASH STANDARD Oil Circulator. Price $108.00 when equipped with 110-220 v. single phase 60 cy. motor.

SEND FOR FULL DETAILS.

There'll be no obligation on your part should you want to find out more about CASH STANDARD Automatic Combustion Control. In one case Automatic Combustion Control enabled a company to use coal costing only $1.35 a ton, helping to cut fuel bill by 30%. Let us send you the important facts — see how you can benefit through this modern plan and through the modern CASH STANDARD System that will give you the means to have a more profitably operating boiler room.

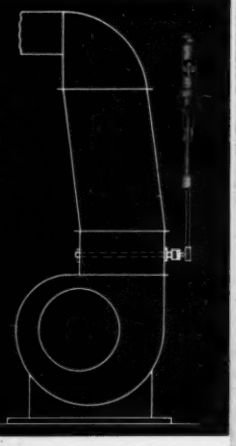


First you buy

(a) Type 90 Furnace Draft Controller with Operating Power Cylinder, and Ball and Socket Joint $ 98.00

Then you add the rest of the system. The typical units shown in the diagram would cost you

(b) Type 100-W Fuel Feed Controller with Operating Power Cylinder and Ball and Socket Joint	$136.00
(c) Type 95 Air Flow Controller with Operating Power Cylinder and Ball and Socket Joint	119.00
(d) Typical Jack Shaft, Levers, and Ball and Socket Joints	45.00
	$300.00



A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD CONTROLS . . VALVES

Note these important advantages you get when you specify WARE HI-LAG FUSES:

1 HIGHER LAG ON STARTING LOADS! Exceptionally high time lag eliminates blow-outs caused by starting motors and momentary surges.

2 GREATER STRENGTH AND DURABILITY! New double-bridge, self-aligned knife-blade assembly insures extra strength and longer life.

3 SIMPLIFIED CONSTRUCTION! New double-bridge assembly easier to renew correctly than to overload. Remove only one end of casing to renew fuse. Assembly may be inserted either end first.

4 SPRING TENSION CONTACT! Greater contact surface. Links will not blow because of inadequate or faulty contacts.

5 MAXIMUM PROTECTION—MINIMUM COST! Underwriters approved. 100% protection to your circuits. Construction insures utmost economy of renewal expense. Saving of lost time will more than pay for the fuses. START ECONOMIZING!

Write for our TRIAL TEST OFFER, Sizes and Prices.

WARE BROTHERS
4500 W. LAKE ST., CHICAGO

Fire Bricks—Advantages of insulating fire brick and their application to boilers and industrial furnaces are brought out in a bulletin, R-2-G on Insulating Fire Brick, just issued. Relationship between weight, heat conductivity and heat storage are described, and illustrated by a 3-curve chart for 6 B & W brick showing the importance of light weight. Guide to application of this brick for industrial furnaces, with tables for various types, also data on panel walls, suspended arches, insulating concretes and special mortars are included. The Babcock & Wilcox Co.

Fire Brick—New folder has just been released containing technical data on the A. P. Green line of insulating fire brick. It contains interesting suggestions in selecting fire brick, also data on properties of the company's product. A. P. Green Fire Brick Company.

Miscellaneous

Technical Information—Fabrication data on monel, nickel and Inconel piping and tubing, including properties of metals, strength under bursting and collapsing pressure, threading, welding, bending and expanding, is given in Bulletin T-17 of the International Nickel Co., Inc.

Dredges—Lawrence announces the issue of its new Bulletin 208-2 covering standard dredging pumps and hydraulic dredge machinery, designed primarily for general dredging service, for pumping sand and gravel, ashes and cinders, and for other applications where the pump is required to handle mixtures of water and abrasive solids. Construction of these pumps is illustrated. Tables give capacities, speeds, and power requirements for different sizes at various heads. Lawrence Machine & Pump Corp.

Waterproofing—Recent additions to Koppers Engineering Bulletins, with technical data, methods of application and construction, include the following: Waterproofing and Gasproofing for Sewage Disposal Plants; Waterproofing and Dampproofing for Waterworks; Membrane Waterproofing; High Penetration Method of Dampproofing; Steep Roof construction with or without roofing bonds; and Roof Bonds. The Koppers Co., Power & Chemical Div.

Tubing—More Heat Transfer Per Foot is the title of a 24-p. booklet on Thermek, an integrally-spined, extended-surface tubing, giving design information on all forms of heat exchange apparatus with best results and savings effected by Thermek. Thermek Corp.

Wall Design—Modern Practice in Baffle Wall Design, Bulletin BW-40, shows the progress in 25 yr. and present types for various arrangements of boilers. Copies available on request. The Engineer Co.

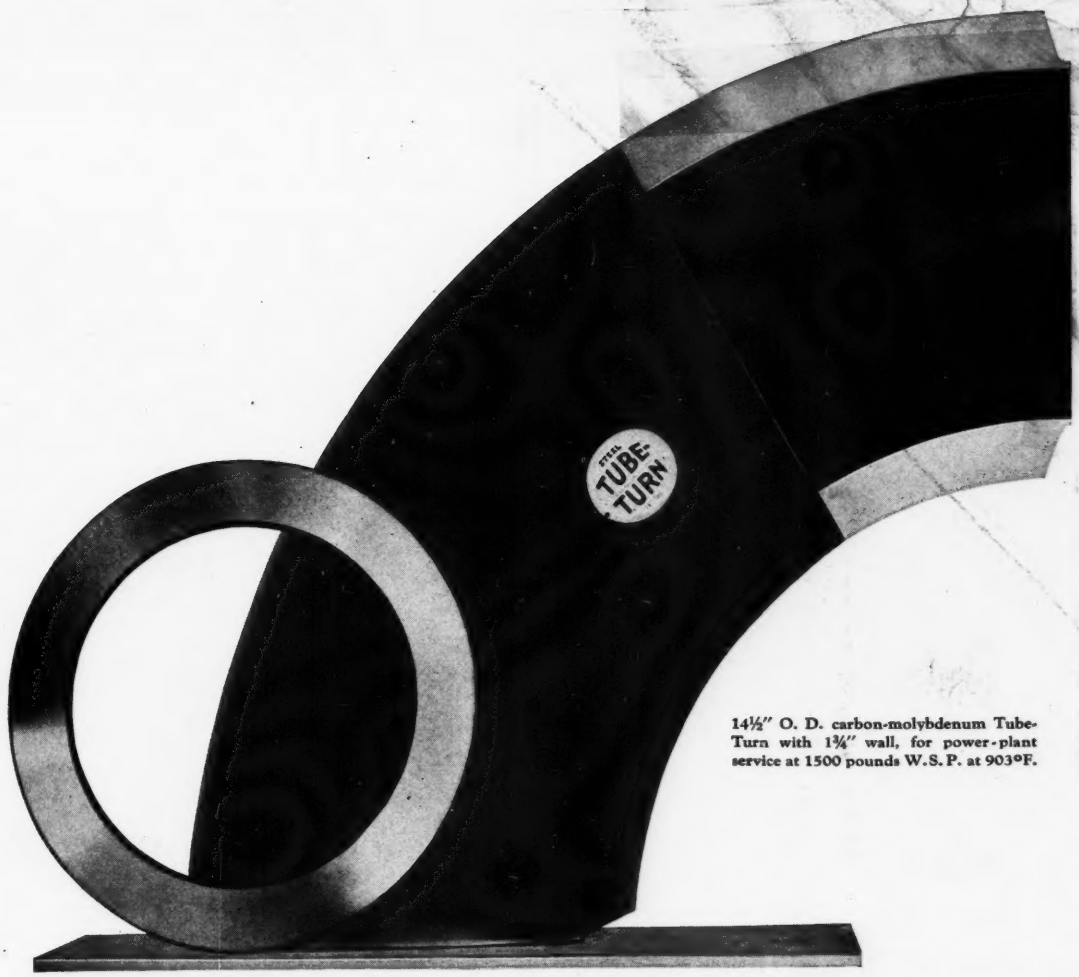
Fire Equipment—In Case of Fire a booklet of 8 pages in 2 colors, illustrated, describes the uses of carbon dioxide for fire extinguishment and shows complete line of hand and wheeled type extinguishers, hose systems, recharging equipment. C-O-Two Fire Equipment Co.

Gratings—Diamond grating, steel stair treads, Hexteel heavy duty surface armor, and Klemp-Acme floorsteel are described in a new 8-pp. catalog with tables of safe loads, information on assembly and with photographs and diagrams showing the various services and methods of using Klemp Products. Wm. F. Klemp Co.

Humidifiers—Armstrong Humidifiers is the title of a new 8-pp. bulletin on the use and application of steam type humidifier for industrial use. It includes data on application, equipment, typical hook-ups and pipe sizes. Armstrong Machine Wks.

Tools—A new bulletin announces the company's own line of GS Machinists' tools, consisting of: combination sets with drop forged hardened square heads, hardened center head, hardened blade and reversible protractor head; a machinists' combination set with hardened blade and center head, protractor and square head of cast iron 4, 6, and 8 in. dividers; 4, 6 and 8 in. inside and outside spring calipers; hardened and tempered center thickness, depth and surface gages and magnifiers. Hook, sliding caliper, flexible and narrow tempered rules are also included in this line. George Scherr Co.

Steel—Methods of fabricating and welding stainless clad steel are to be found in a new 16 pp. booklet Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel. Ingersoll Steel & Disc Division, Borg-Warner Corp.



14½" O. D. carbon-molybdenum Tube-Turn with 1¾" wall, for power-plant service at 1500 pounds W.S.P. at 903°F.

TUBE-TURNS for "TOUGH STUFF"!

The big boy above, Gentlemen, is a pretty good example of what we can do in the way of making Tube-Turns for the toughest sort of high-pressure piping.

But even more impressive, *we* think, is the fact that *all* Tube-Turns—from light-gauge elbows, on up to the biggest, heaviest specials—are made by exactly the same exclusive Tube-Turn process, and give you exactly the same qualities of strengh, economy and dependability in your welded piping.

Because of their unapproached records of successful use in every line of industry, most engineers *prefer* Tube-Turns. That preference is deserved. If you want to know how fully it is deserved, read the new Tube-Turn Catalog and Data Book No. 109. Ask your distributor for a copy, or write us direct. Address: Tube-Turns, Incorporated, Louisville, Kentucky.

PIPEWRENCH PETE SAYS:

Here's NEWS about CONTINUOUS BLOWDOWN

NEW ACCURACY, NEW ECONOMY!

NEW ACCURACY! Visual metering, plus restricted seat.

NEW ECONOMY! Anum-Metl "X" seat and disc last longer than Anum-Metl!

SHOWN: Strong Type SOCBX Valve. List prices: ½"—$20; ¾"—$24.75; 1"—$31.00 (And well worth it!)

NEWEST MEMBER OF STRONG LINE HAS BEEN SELLING ITSELF!

Before this announcement, we made sure that Strong's Continuous Blowdown valve had earned its place in Strong's complete line of valves. Developed two years ago, it sold itself—first proved its advantages in important installations, so you can buy it today with confidence!

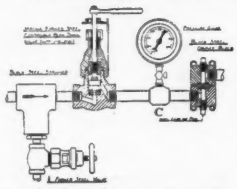
Its Anum-Metl "X" seat and disc offer almost diamond surface hardness—750 Brinell. For less severe usage, regular Anum-Metl lasts up to 8 times longer than the long-lived metal it replaced.

Call your distributor or write for Catalog 101 on Strong's full line of valves for severe service!

* * * *

CATALOG 176—Strong boiler feeders and liquid level controls. Features non-liming, Anum-Metl seats and discs.

"VOLUMETERING" HOOK-UP



Combination of valve and fixed orifice results in pressure drop and increase in blowdown volume at C. Gauge shows pressure drop, permitting visual control.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

STRONG
STEAM SPECIALTIES

Parts Per Million in Water Analysis

IN ANALYZING water, determination of extremely small amounts of foreign matter is required and, if expressed as a percentage they would be a few thousandths of one per cent, requiring long decimals. To avoid this, impurities are given in parts per million, 1 p.p.m. = 0.0001 per cent, or 1 p.p.m. is 1 oz. of impurities in 1,000,000 oz. of water. This method of expression has been adopted as standard by the U. S. Government and practically all scientific societies and laboratories, but as some few concerns still use grains per gallon, the conversion factors to make the change are as follows:

1 gr. per U. S. gal. = 17.1 p.p.m.
1 p.p.m. = 0.0585 gr. per U. S. gal.

Replacement of Tin-Bronze

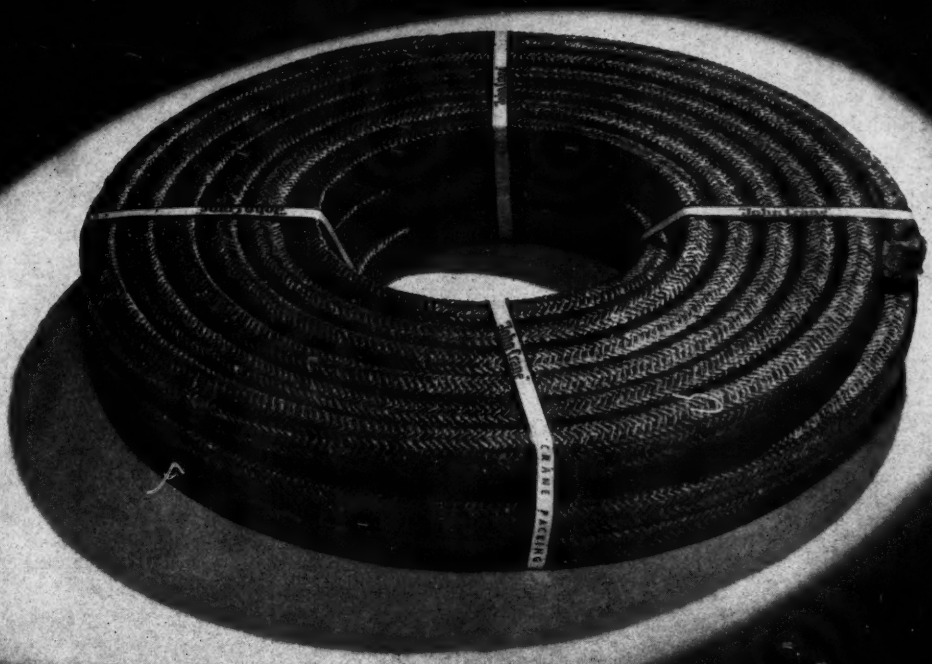
TIN SHORTAGE in the first World War started a search for a lighter and stronger metal for casting and resulted in development of an alloy of silicon, copper and iron, known as "P-M-G" metal, having lower specific gravity, greater strength and greater resistance to fatigue and shock than the usual tin bronzes. Use of this metal permits reduction of weight in naval construction, as well as giving resistance to sea water corrosion, hence will play an important part in construction of our new navy. It will also be used in army ordnance such as fire control instruments, loading equipment for big guns and the like.

In industry it has application for valves, couplings, pump shafts, tunnel and bridge construction and wherever light weight and corrosion resistance are essential. Manufacture in the United States and Canada is controlled by Phelps Dodge Copper Products Corp., the original patents being held by Vickers-Armstrongs, Ltd., of England.

Bonneville Dam Power Rates

WITH CONTRACT for 2000 kw. of prime power and additional surplus power by Grays Harbor County (State of Washington), commitments of the Power Administration for Bonneville Plant reach 202,300 kw., with present installed capacity of 86,400 kw. Additional capacity is expected to be ready in time to meet delivery obligations.

The Navy SIGN OF APPROVAL



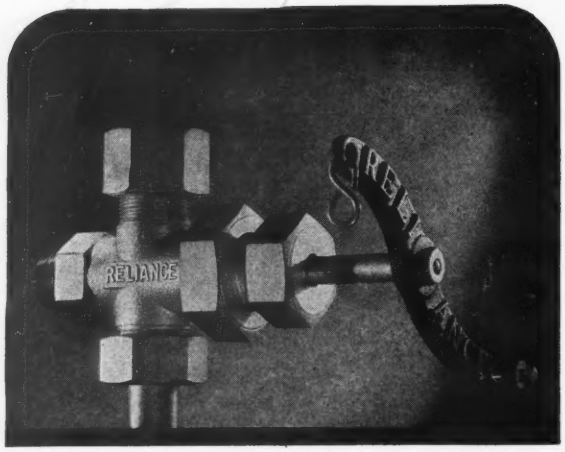
"JOHN CRANE" STYLE 6AM PACKING

600 POUNDS
PRESSURE
750°F

Super Heat

VALVE STEMS
EXPANSION
JOINTS

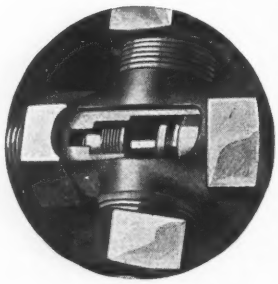
CRANE PACKING COMPANY, CHICAGO, U. S. A.
CRANE PACKING COMPANY, LIMITED · · · HAMILTON, ONTARIO, CANADA



For Dependable Low Upkeep Service on High Pressure Gages . . . *specify Reliance*

FORGED STEEL GAGE VALVES

You avoid the trouble and expense of frequent repairs and replacements with these long-life Reliance Valves. The sturdy forged steel bodies, flanges, packing nuts and glands are made of tough SAE 1025 steel. Valve is regrinding type, seats removable and reversible — of long-wearing stainless steel. The stainless stems have multiple threads for quick closing. Complete shut-off in a quarter turn • Moulded packing rings for stems and glass-ends withstand high temperature service in steam, oil and chemicals. Extra deep stuffing boxes assure *leak-proof* assembly. • Thousands of Reliance Forged Steel Gage Valves are in use, saving operators from the maddening sizzling and sputtering around water columns.



Write today for Bulletin 401.

THE RELIANCE GAUGE COLUMN CO.
5902 Carnegie Avenue . . . Cleveland, Ohio

Reliance
Boiler Safety Devices since 1884

Grays Harbor contract is for 20 yd., with immediate delivery at Cosmopolis on the outskirts of Aberdeen over a line from Raymond to Cosmopolis connecting to a transmission system from Bonneville Dam through Vancouver and Chehalis.

Standard resale rates for residential use are to be 3½ cents per kw-hr. for the first 50 kw-hr., per month, decreasing on a sliding scale to 1½ cents for up to 200 kw-hr., to 1 cent for up to 300 kw-hr. and to ½ cent for up to 1200 kw-hr. For commercial use the rate will be 3½ cents for the first 100 kw-hr., 2 cents for up to 900 kw-hr., 0.6 cent for up to 15,400 kw-hr., and up to 100,400 kw-hr. and over per month 0.3 cent per kw-hr.

It is expected that by applying all revenue from resale, above the cost of maintenance and operating expense, to reducing resale rates, the actual rate will drop as follows: 3 cents per kw-hr. for the first 50 kw-hr. per month to ½ cent for 1200 kw-hr. or over on residences, and 3 cents for the first 150 kw-hr. to 0.3 cents for 100,000 kw-hr. and over.

Co-operation in Chemical Research

As an example of coöperation of universities in commercial research, the University of Iowa has granted a year's leave of absence to Dr. Edward Bartow from the department of chemistry and chemical engineering to investigate chemical problems in connection with the products of Johns-Manville Corp.

Dr. Bartow, who received his A. B. degree at Williams College in 1892 and Ph. D. from University of Gottingen in 1895 has served in the faculties of Williams College, Universities of Kansas, Illinois and Iowa, holds membership in American Chemical Society, other chemical and engineering societies, has made frequent trips to Europe as delegate to chemical and industrial conventions, has written many papers on water purification, sewage disposal, treatment of trade wastes, has been on the editorial staff of Chemical Abstracts since 1911 and is author of Reports on Chemical and Biological Survey of Water of Illinois. He was a former president of American Chemical Society and of the American Water Works Association.

It is announced by L. R. Hoff, vice-president, that for the coming year, Dr. Bartow will act as chemical consultant for Johns-Manville Corp. in connection with its research laboratories, and will be located at Manville, N. J.

Finding Oil Fields

Science has so developed its methods of field exploration for oil that 94 per cent of all major oil fields discovered from 1922 through 1938 were located by geological and geophysical science. Wildcat drill-

THE SAME OLD R.P.Ms BUT..

LARGER SPROCKETS	MORSE *Silent* CHAIN
EQUALS MILE A MINUTE CHAIN SPEEDS	GREATER CAPACITY AT LOWER COST

PLUS *AND*

IT IS A simple matter with Morse Chain! Simply by using larger sprockets with more teeth, jumping chain speeds up to mile-a-minute, Morse Chain's power transmitting capacity is multiplied.

This treatment results in slip and wasted power in other types of drives, but not in Morse Chain drives. The silent chain actually utilizes centrifugal force to produce better contact with sprocket teeth, and more even load distribution.

Morse Silent Chain, operating at mile-a-minute speeds, is so silent you scarcely hear it. There's no noise of strain or overloaded bearings. Load capacity rises tremendously with chain velocity. Wear is at a bare minimum, because the load is distributed over multiple chain and sprocket teeth. Chain width greatly reduced. Efficiency is 99.4% for the life of the drive with high velocity silent chain.

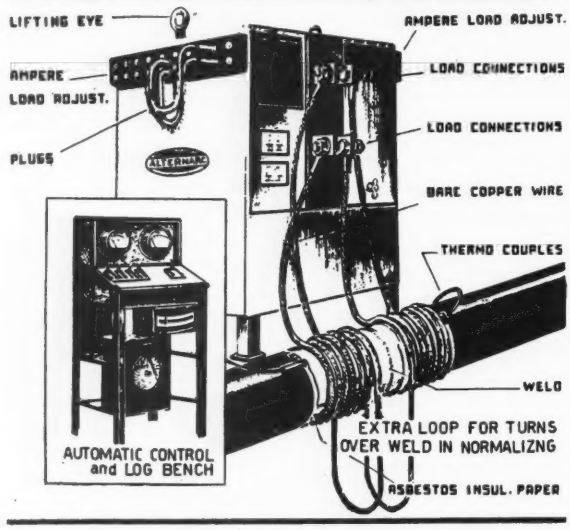
Morse High Speed Silent Chain drives can probably work profitably for you. Applicable to speeds from 400 to 4000 r.p.m. Ask the Morse man in your territory for full information. Or write Morse, Ithaca.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

THE *Simplest Way* OF PREHEATING-WELDING NORMALIZING is the Smith-Dolan Way



THE Smith-Dolan System is the best way of welding high pressure boilers, piping, valves, turbines, penstocks, etc.

With this advanced system you preheat with a.c. hysteresis induction coils wrapped around both sides of the joint about to be welded, then apply a suitable current.

Welding the Smith-Dolan way is simplified because the wrapped preheating coils are not removed. An opening is provided and the welder just deposits the metal.

Stresses and strains are eliminated because the metal has been brought to a proper temperature for preheating and for normalizing the weld. Many plants use this electrical system for heat treating Diesel crankshafts, gears and other live load welding.

Automatic heat control within 1 deg. is feasible with the Smith-Dolan System. It is also safe—low voltage prevents scarring metal. It saves time and money because heating can be done in place. And it heats any size or shape of metal or pipe. Tell us about your welding needs. Write for New Bulletin.

See our Demonstration, Booth 505
NEW YORK POWER SHOW
December 2 to 7

Electric Arc
CUTTING & WELDING CO.
152 Jelliff Ave. Newark, N. J.

ing discovers a few fields each year, some of them of sizable extent, but "hunch" drilling is on the way out. Of the 796 major pools located from 1922 to 1938, 746 were by scientific exploration and only 50 by random drilling.

By use of the seismograph, electric log, gravity meter and other tools, underground rock formations, pools under lakes, oceans, swamps are charted and pools located. Crews have increased from 115 in Jan., 1934, to 290 in 1938, estimated cost of operation being $75,000,000 for the 5-yr. period, but exploration has discovered fields with estimated ultimate production of fourteen billion barrels, so that although costly, the scientific exploration is profitable.

Creep in Metals

IN THE General Electric Research Laboratory, R. H. Thielemann is delving into the stretch or creep of metals as used in industry. While both tar and steel are rigid when cold enough and stretch when heated, the former gives quick evidence of its stretch on a hot day, but steel must be measured closely and over periods of thousands of hours to determine how much it stretches and what is allowable for different conditions.

Parts of steam turbines operate at dull red heat and are expected to give service continuously for years, yet dimensions and clearances must vary very little. For boilers and similar constructions, allowable stretch is much larger, but special steels are required for strength. Steels and alloys have varying characteristics. Some may stretch 50 per cent before breaking; others only a slight amount before overstress causes fracture. It is vital to know how each kind of steel or alloy will act so that the proper kind may be chosen for different conditions. Many steels which are satisfactory at usual temperatures will have large stretch and fail, if red hot, at high stresses. With lower stresses, creep may be so small as to give long-time service even at high temperatures.

Mr. Thielemann is, therefore, gathering information as to behavior of metals at high temperatures, with varying stress from low to breaking, so that creep and rupture properties may be known to govern selection of materials in engineering design.

50,000 Kw. Floating Power Plants

POWER PLANTS which can be towed through America's coastal and inland waterways and hooked up to regular distribution lines to generate electricity in emergencies may be a factor in the National Defense Program, said A. P. Kellogg of the General Electric turbine division, speaking before the Wisconsin Utilities Association at Milwaukee. Mr. Kellogg said that a recent study showed a large portion of the eastern

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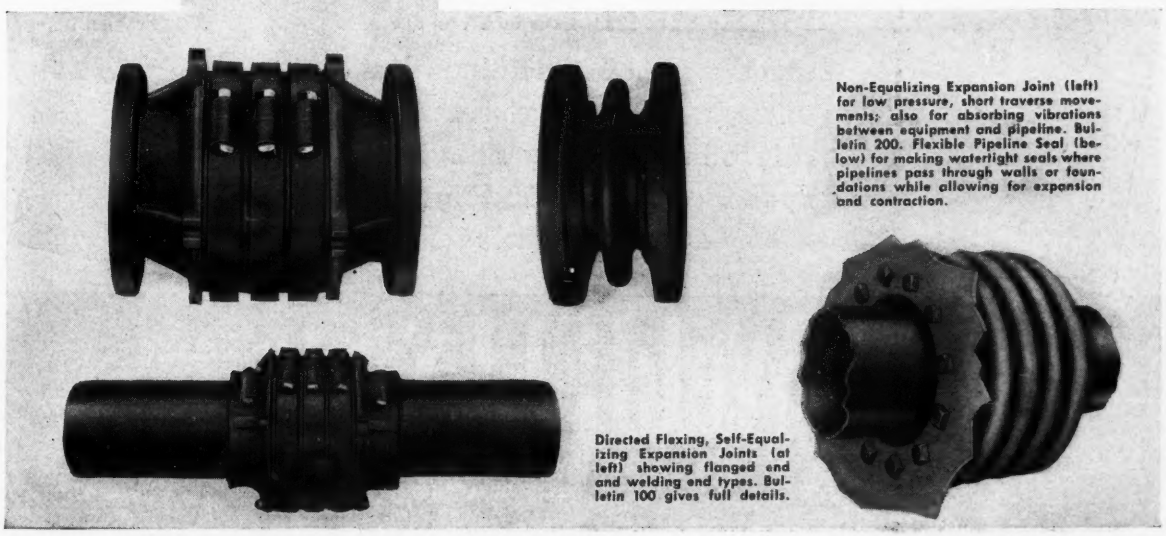

Non-Equalizing Expansion Joint (left) for low pressure, short traverse movements; also for absorbing vibrations between equipment and pipeline. Bulletin 200. Flexible Pipeline Seal (below) for making watertight seals where pipelines pass through walls or foundations while allowing for expansion and contraction.

Directed Flexing, Self-Equalizing Expansion Joints (at left) showing flanged end and welding end types. Bulletin 100 gives full details.

United States and the West Coast could be reached by generating stations housed in vessels designed to pass through the New York State Barge Canal.

A projected 50,000-kw. self-contained floating power plant is being studied, this seeming to be the largest rating practicable; of course, such plants can be built in any ratings under 50,000-kw. The equipment of such plants closely follows standard marine and central station practice with modifications necessary to meet low head room.

Complete 50,000-kw. steam generating station could be housed in a hull similar to that of a lake freighter, with dimensions of overall length of 290 ft., 43-ft. beam, 10-ft. draft, and a low bridge clearance of 15 ft.

Floating power plants are not new. The U.S.S. Lexington, a turbine-electric drive battleship, supplied much needed power to the City of Tacoma, Washington, in 1929 when shortage of water power reduced supply below the city's requirements. Two 10,000-kw. turbine-generators were installed in the hull of the Jacona, built during the last war, and it has been used by the Public Service Co. of New Hampshire as a floating power plant since 1930.

For National Defense

Mr. Kellogg pointed out that yearly station peaks vary on many of the large utility systems, and if one or more floating power plants were available they could be moved from one power house to another as load requirements dictated.

With the present rapid expansion of industrial loads in locations which are hard to predict, the floating power plant can be placed at an advantageous point on short notice; on larger systems, where it is known that the total load will grow during the next 2 or 3 yr., but where it is difficult to decide upon the cost economical location for a new generating unit, one power barge could be used at any point until permanent power plant could be built. As an auxiliary to the National Defense Program, the value would be great, since additional power could be made immediately available for replacing damaged facilities or increasing production.

For the 50,000-kw. floating power plant under consideration, four boilers would be used, similar to the standard oil-burning, marine-type boiler, with the addition of an air preheater and a somewhat smaller economizer. Stacks would be made with separable connection so that they could be removed for transportation beneath bridges.

Steam turbine would be direct-connected to the main generator and to a house generator which would carry the auxiliary load. It would operate at 3600 r.p.m. and be of the tandem-compound type, double-flow with side exhausts. The steam cycle could be comparable with standard central station practice, with the same steam pressure and temperature, and full feedwater heating system.

Main generator would be rated 50,000-kw. at 0.8 power-factor, 62,500 kv-a., 3-phase, 60 cycles,

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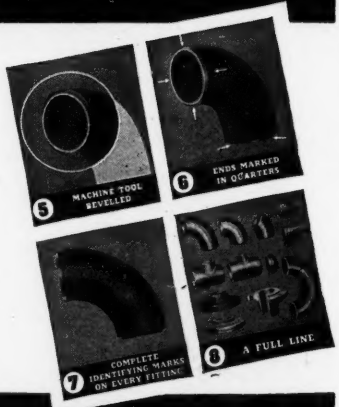

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13,800 volts. Direct connected to the main generator would be a house generator rated 3500 kw., main and pilot exciters, and a house exciter. The main generator would be hydrogen cooled with the surface gas coolers within the generator casing. A surface air cooler would provide cooling air for the house generator.

Diesel Auxiliary

Condensers would be horizontal tube, single pass, similar to the usual central station design, except that steam connections would be at the side.

Auxiliary equipment would be similar to the usual central station, with feedwater heaters, deaerator, makeup water and storage tank, fuel oil pumps, boiler feed pump, and forced draft fans.

So that the unit could be started from cold, an auxiliary Diesel-driven generator of approximately 500-kw. capacity would be included. Some lights and a small amount of power would probably be required while the vessel is being towed and a gasoline or Diesel-driven generator of about 20-kw. would be needed for this purpose.

Fuel oil and fresh water tanks to be carried in the hull would have a capacity for 10 to 15 hr. operation, so that the floating power plant could operate immediately on its own until a supply tanker could be brought alongside.

Plans for the hull also call for a double bottom for fuel or water storage or ballast, which would permit lightening the vessel to get over shallow draft points or taking on extra weight to get under low bridges.

Accommodations would be included in the plans for the crew's offices, locker room, washroom, and mess hall.

Mr. Kellogg stated that the operation of such a plant would be comparable with that of a good, modern central station. Performance at full load is estimated at 12,000 to 12,500 B.t.u. per kw.-hr., figured on the basis of power output from the vessel and including all auxiliary requirements.

Coal Test Code

CODE FOR testing coal is being developed by a joint committee of A.S.M.E. and A.I.M.E. acting through three sub-committees; the first on history, preparation, laboratory tests and descriptive data of coal as delivered to the furnace; the second on outline of code of observations and tests to be made to evaluate fuel for underfeed stokers; the third on code for observations and tests to be made to evaluate fuel to be burned in suspension. The committees are at work and made a progress report at a joint meeting in Birmingham, Ala., on Nov. 7. The field covered is fuel for use in steam generation, kilns, gas producers, metallurgical furnaces and carbonization processes, and will need collaboration of the Iron & Steel Institute, Foundrymen's Association, Stoker Manufacturers and Heating and Ventilat-

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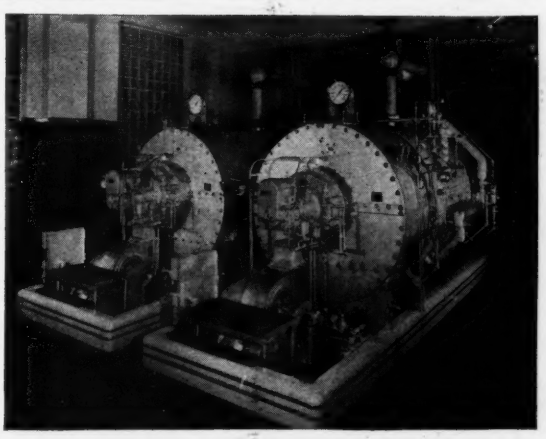

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ing Engineers. Coöperation of all members of societies in suggesting observations to help evaluate coal for any purpose is desired, so that standards for testing coal may be formulated and testing technique improved.

Plant Housekeeping

IN A PLANT, as in a household, the comfort and good spirit of occupants are the chief objectives of good housekeeping. Cleanliness, order, environment which inspires by good example to good performance are requisities for good morale. Good heating and ventilation, adequate sanitary facilities and lunch quarters are, of course, essential, and simple and convenient arrangement makes for effectiveness.

As an example, of attention to good example, F. W. Howe of Brown & Sharpe saw a brick wall being built with crudely finished inside. He ordered it rebuilt, even though it was well toward completion, so that the workers in the room might have a good piece of work in front of them as a standard, as well as the pleasure of satisfying surroundings.

Importance of good air conditioning is now well understood, to health as well as to working comfort, and effective lighting, both general and local is recognized as good economy. Washroom facilities and where needed, showers, to let workers leave the plant feeling refreshed to meet their families, are appreciated by both workers and families. But cleanliness, disinfection and safe footing must be rigidly maintained. Spray fountains and liquid or powdered soap dispensers are sanitary and have proved economical. Clean, sanitary and deodorized toilets hardly need emphasis.

Safety and accident prevention are recognized as essentials, but need to be kept continuously in the consciousness of workers, for humans are prone to take chances, and only in constant vigilance lies security. All hazards should be eliminated so far as possible and caution be emphasized by rules, notices and admonition, with recognition in each department for a clean score in accidents and injuries, and reprimands for carelessness in observing rules or failing to use safeguards. Foremen, superintendents and older employes should form safety committees in each department. First aid equipment should be provided at convenient points and prompt attention given to every injury, no matter how trivial it may seem, as infection or after effects of strains and bruises may be dangerous.

To sum up, good plant housekeeping requires the same intelligent attention to health, comfort, safety and pleasant surroundings as is involved in home housekeeping and involves the coöperation of workers that such conditions are established and maintained. This is for the benefit of workers. It is their job, as much as that of the management. And each individual should accept his own responsibility and encourage all others in the organization to do likewise.

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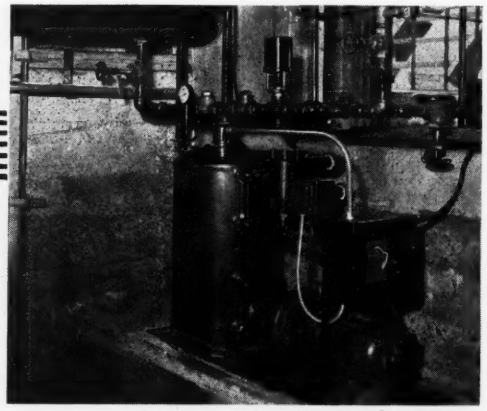

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New Engineering Books

Unsolved Business Problems. By Johnson O'Connor. Published by the Human Engineering Laboratory, Inc., 347 Beacon Street, Boston, Mass. Size 5½ by 8½ in., paper bound, 135 pages. Price $2.00.

Proper personnel selection, probably industry's most important problem, is today being solved largely by cut and try methods. Merchants and manufacturers keep a careful inventory of materials but only a very few even attempt to inventory the abilities and aptitudes of their employees.

The bulk of the population possesses from 4 to 9 separate aptitudes or the ability to do these many different things with above the average ability. Few industrial applications demand the use of one or at the most two of these aptitudes and the others lie dormant. If a proper inventory of these aptitudes are available, personnel problems would in many cases be made much simpler by transferring employes from one department to another rather than hiring an inexperienced outsider.

This book is a critical examination of the 13 aptitudes that can now be definitely measured. These 13 are: personality; accounting; structural visualization; creative imagination; inductive reasoning; analytical reasoning; observation; finger dexterity; tweezer dexterity; muscular speed; number memory; tonal memory; and design memory.

In addition to considering the aptitudes singly, the book considers them in combinations, with particular reference to definite jobs or professions. For instance, a good production expiditer or chaser so important in production control, will in general rate high in number memory, high in accounting aptitude and have an objective personality. Engineers, inventors, surgeons, executives, etc., each have distinct combinations of aptitudes in which they excell and which is largely responsible for their success in a given field. Some men can do only one thing well, some can do several things equally well if the need or necessity arises. The book is a complete treatment of the investigations summarized briefly in the article "The Right Job" on page 72 of the February 1940 issue of POWER PLANT ENGINEERING.

Steam and Hot Water Fitting. By William T. Walters. Published by the Americal Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in., cloth bound, 180 pages. Price $2.00.

The object of this book, as set forth in the preface, is to tell how to design the system according to good practice and common sense; how to select the best equipment for the system and know what each part of the system should do; and how to install each part correctly so that it will function at its maximum efficiency. The book is, therefore, of a very practical nature, intended for steam fitters, engineers, draftsmen and designers. It is divided into a number of chapters including boilers, steam radiators and coils, steam heating systems, vapor heating, vacuum systems, pumps, pipe and fittings, valves, unit heaters, pipe fitting tools, greenhouse heating, hot water heating systems and panel heating. It is well illustrated with typical layout drawings, modern equipment, curves and engineering tables.

Engineer-Custodian's Manual. By Thomas J. Brett. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago. Size 5½ by 8½ in., cloth bound, 185 pages. Price $2.50.

Over 500 examination questions covering boilers, combustion, engines, heating and ventilating, air conditioning, pumps, sanitation and plumbing, electrical machinery, mechanics, technical formulas, etc., are included in this book, written by the Engineer-Custodian of the Chicago Board of Education with a background of many years supervising school engineers and conducting engineers' training classes. As such it is a book for the practical man, for building managers, engineers, custodians, firemen, caretakers and electricians. The answers are simple, in an informal style but technically correct—a specific answer to the question and not simply a general statement of the principles and theory. The last chapter of 35 pp. is a very complete collection of formulas, tables and general engineering information.

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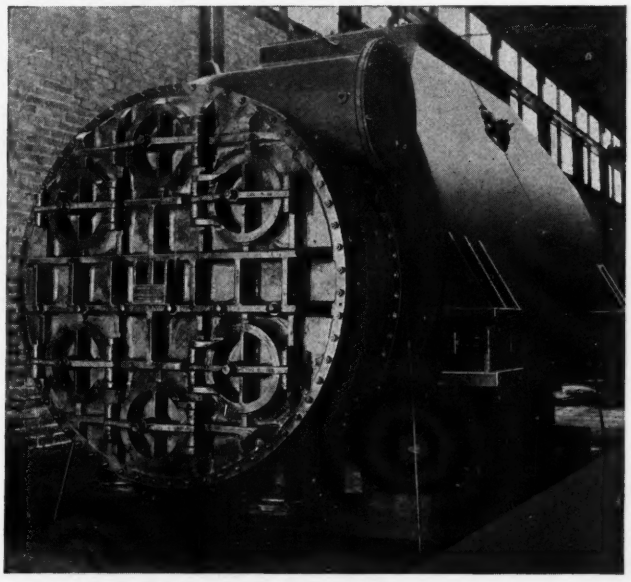

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Handbook of Chemistry and Physics. 24th Edition. 2581 pages size, 7⅛ by 4¾ inches, flexible fabricoid, stamped in gold. Published by The Chemical Rubber Co., 1900 West 112th Street, Cleveland, Ohio. 1940. Price $3.50.

Here is the 24th edition of this useful and well-known book, larger and more complete than ever. Although, as its name implies, it is fundamentally a handbook on Chemistry, it is essential to anybody associated in any degree with physics, mathematics, engineering, biology, astronomy, metallurgy and related sciences. This edition contains 688 pages of new composition—342 new pages. The data contained in the book is classified under five general divisions, separated for convenience by divisional guides. Division I consists of mathematical tables and contains 320 pages. This list is very comprehensive and satisfies the requirements of all the usual courses of pure and applied mathematics and also the needs of engineers and others engaged in industry. Division II, entitled Properties and Physical Constants, while of direct interest to chemists is nevertheless of great value to others engaged in scientific or engineering work. The same is true of Division III, General Chemical Tables and Specific Gravity and Properties of Matter. Division IV includes information on Heat, Hygrometry, Sound Electricity and Magnetism, and Light. Finally Division V is devoted to Quantities and Units, Conversion Tables and Miscellaneous Tables that are needed daily by scientists generally. Compiled by 164 editors and collaborators, each an authority in a special field of scientific work, the data is authentic and of the highest degree of accuracy. What is perhaps most astonishing is how such a tremendous mass of material can be assembled in book form and sold at a price of only $3.50.

Matrix and Tensor Algebra. By Clarence E. Rose. First edition. 143 pages, size 5½ by 8¼ in., cloth. Published by Chemical Publishing Co., Inc., New York, N. Y. 1940. Price $4.00.

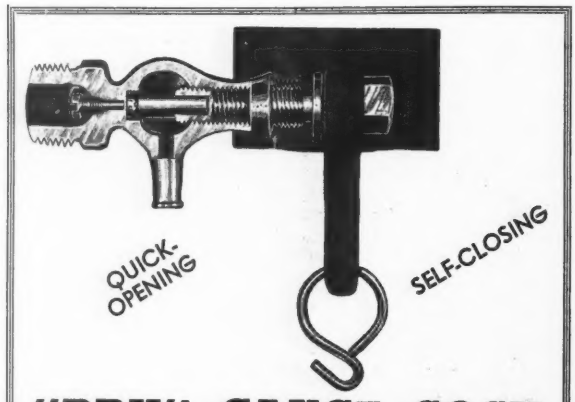
Many of us who have maintained a more or less sustained interest in mathematics regardless of whether or not we found use for it in our work have been intrigued by the curious configuration of symbols which have appeared from time to time in recent years in certain mathematical treatments of engineering subjects. We were told these configurations of symbols were part of a branch of mathematics called Tensor Algebra. A number of articles appeared from time to time purporting to explain Tensors in simple language but after struggling with these expository treatises only too often, in the words of Omar Khayyam, we came out by the same door where in we went. Perhaps the fault was ours but in view of these circumstances it is gratifying to find a book which appears to handle the subject of tensors in a clear and understandable manner. Clarence Rose, the author of this book, is an engineer in the Navy Department at Washington, D. C., and a member of the American Institute of Electrical Engineers. As a result of teaching the subject for a number of years he wrote this book which presents all of the mathematical operations of determinants, the essential ones of vectors, and all of those of tensors—with examples at the end of each chapter.

The book has been written so that anyone possessing the rudiments of the differential calculus can readily interpret it by home study. It is well indexed so that it can be used as a handbook on this subject. This is important because such items as the differentiation of tensors are not readily committed to memory.

As the author points out, the book was written primarily for electrical engineers and chemists to enable them to read an increasing number of technical books and articles employing matrix algebra and tensor analysis. Each algebraic process has been developed step by step in full and the first chapter links the subject matter directly to algebra, trigonometry, plane and solid geometry and the simplest of differentials. A small book but it contains a powerful lot of information.

Arc Welding Handbook. By Karl Meller. Translated from the German by J. E. Webb Ginger. 210 pages, illustrated; size 5 by 7 in., cloth. Distributed by Chemical Publishing Co., Inc., New York, N. Y. 1940. Price $3.50.

The object of this handbook is to enable the operator to understand the processes involved in arc welding and to utilize the results of the latest research in improving and simplifying his work. It will also be found useful to foremen and others entrusted with the training of welders, and of assistance in determining their progress. The welding engi-



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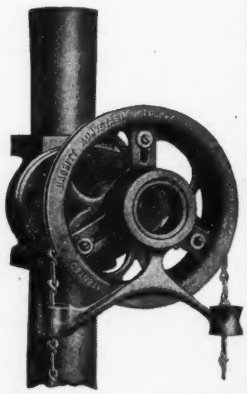

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neer will derive considerable interest from the descriptions of plant and equipment, and more especially from those pages devoted to the choice and testing of electrodes. The most comprehensive section of the book is that dealing with the welding of steel since this is a subject of especial importance. The book concludes with a chapter on the testing of welded joints and the examination of welding operators.

Refrigerating Data Book. Vol. II. Applications Edition. 413 pages plus 108 page catalog section. Cloth; 7 by 9½ in. Published by The American Society of Refrigerating Engineers, 37 W. 39th St., New York, N. Y. 1940. Price $4.00.

This is the fifth of a series of books which have been published every other year since 1932. The previous four books had virtually identical scope, being devoted to refrigerating principles and machinery. The fourth edition appearing in 1939 was designated as Vol. I as a companion to this book which is called Vol. II. This new 1940 edition (Vol. II) is entirely different from any preceding volume. It consists wholly of practical chapters on all the known applications of air conditioning and refrigeration. It carries information of a scientific and popular nature on scores of industries using refrigeration processes. It tells how refrigeration and air conditioning are actually used in these industries.

The book is divided into seven sections with titles as follows: I, Freezing Processes. II, Refrigeration in Processing. III, Cold Storage. IV, Distribution of Foods. V, Industrial Refrigeration. VI, Comfort Air Conditioning. VII, Industrial Air Conditioning. The back portion of the book is a catalog section consisting of advertisers, index by products, directory of distribution and a membership list of the A.S.R.E.

Hotel Engineering, Volume I, Water Consumption, Cost and Savings. By George C. St. Laurent. First of five books to be published on various phases of hotel engineering problems and economies by the American Hotel Association of the United States and Canada, 221 West 57th St., New York, N. Y. 1940. Price, $1.00; paper bound, 7¼ by 10½ in., 32 pages.

This book tells what to do if your water consumption is high, recites many ways of cutting down on consumption and carries fourteen pages of tables giving facts and figures on the subject from hotels of every type and size in every state. Headings in some of the columns are: Ratio of Food and Beverage to Room Sales; Total Water Consumption Cost in 1939; Water Consumed Per Occupied Room; Water Consumed Per Available Room; etc. The statistics have been arranged so that the hotel operator can easily select the group of hotels with which his particular hotel compares most closely.

The Lincoln Weldirectory, 58 pages, 8½x11 inches, 165 illustrations, paper cover, published by The Lincoln Electric Co., Cleveland, Ohio.

This book deals with the procedures for producing all types of welds in mild steel, for welding all metals used to any extent industrially and for applying surfacing metal to meet any type of wear-action in service.

Included among the procedures are recommended current ranges and arc voltages; suggestions regarding arc length, polarity of welding current, distance to hold electrode from work, cleaning beads, welding up or down, use of wide and narrow beads, peening to increase hardness, quenching, weaving the electrode, etc. Properties of welds produced in various metals are given and typical welding applications and arc welding accessories are illustrated.

Additional features are a chart serving as a guide for selection of electrodes for various applications and a 2-page illustrated section giving information and pointers on the proper use of modern shielding arc welding. A 10-page section covers the subject of surfacing with arc welding and includes a chart for selection of electrodes for this important branch of welding. The book is available upon request.

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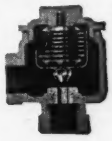
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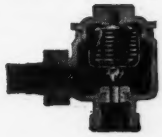
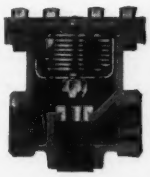

Type AU

has from two to six times greater capacity than average traps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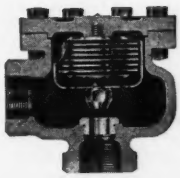
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Power Plant Construction News

Ala., Birmingham—Tennessee Coal, Iron & Railroad Co., Birmingham, plans extensions and improvements in steam-electric power plants at different mills and raw material properties, with installation of equipment for increased capacity. Work will be carried out in connection with a general expansion program to cost over $20,000,000.

Calif., Modesto—Pacific Can Co., 290 Division Street, San Francisco, Calif., plans installation of electric power equipment in proposed new branch plant on site acquired on Santa Rosa Avenue, Modesto. A boiler plant is proposed. Entire project will cost over $175,000.

Calif., Pasadena—Municipal Light and Power Department, Benjamin F. DeLanty, manager, has tentative plans under consideration for new steam-electric generating station to augment present plant facilities. It will have a capacity of about 35,000-kw., and is reported to cost close to $2,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment. C. W. Koiner is city manager.

Conn., Hartford—Colt's Patent Fire Arms Mfg. Co., 17 Van Dyke Avenue, manufacturer of fire arms, ammunition, etc., plans installation of electric power equipment in connection with plant expansion for munition production for Government, Army Department, Washington, D. C., will furnish fund of about $8,074,400 for project, majority to be expended for machinery and equipment. Proposed to begin work soon.

Del., Newark—Board of Directors, University of Delaware, Walter Hullinen, president, is considering new power house for central-heating service at institution. Cost reported over $150,000. Project is now in preliminary stage.

Ga., Macon—Quartermaster General Office, United States Army, Washington, D. C., plans power house at new army replacement camp on former site of Camp Wheeler, Macon. Also will install power equipment in shops and other buildings. Fund of about $5,500,000 has been arranged for entire project. Proposed to begin work soon. Hentz, Adler & Sbutze, and J. Warren Armistead, Jr., Candler Building, Atlanta, Ga., are architects; Newcombe & Boyd, Trust Co. of Georgia Building, Atlanta, are engineers.

Ga., Macon—Reynolds Metals Co., Federal Reserve Bank Building, Richmond, Va., plans power house at new plant near U. S. Highway No. 41, about 3 miles from Macon, where large tract of land has been acquired. It will comprise group of about 20 one-story buildings, to be equipped for fuse production for Government. Electric power equipment will be installed for plant service. Entire project reported to cost close to $1,000,000. Work will begin soon.

Ill., Rockford—W. F. & John Barnes Co., South Water Street, plans installation of electric power equipment in one-story addition, 170x215 ft., to machine tool-manufacturing plant. Entire project will cost over $125,000. Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, engineer and contractor, has contract for design and erection.

Mass., Peabody—Eastman Gelatine Co., 217 Washington Street, plans installation of electric power equipment in one-story addition, 75x400 ft., to food products-manufacturing plant. Entire project reported to cost to $150,000. Work will begin soon.

Mich., Plymouth—Kelsey-Hayes Wheel Co., 3600 Military Avenue, Detroit, Mich., manufacturer of steel wheels for automobiles, etc., plans power house at new plant at Plymouth. Also will install electric power equipment in manufacturing buildings. Entire project reported to cost over $400,000. Work is scheduled to begin at once.

Mich., Trenton—Monsanto Chemical Co., 1700 South Second Street, St. Louis, Mo., plans power house at new chemical plant at Trenton, where large tract of land was acquired a number of months ago. Also will install electric power equipment in main factory units. Entire project will cost close to $3,000,000. Plans are being completed by Harley & Ellington, Stroh Building, Detroit, Mich., architects, and work will proceed at early date.

Mo., Lake City—Remington Arms Co., Barnum Avenue, Bridgeport, Conn., plans power house at new plant to be built at Lake City, near Independence, Mo., for production

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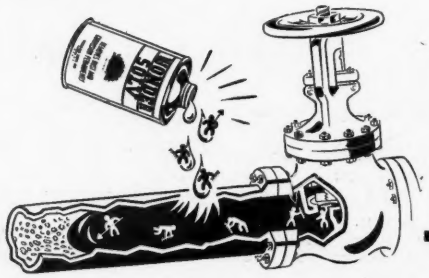

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of small arms ammunition for Federal Government. It will comprise a series of one and multi-story buildings, equipped for large output. Electric power equipment will be installed. Cost estimated about $12,000,000. Project will be carried out in coöperation with War Department, Washington, D. C., which will furnish fund noted.

Mo., St. Louis—Curtiss-Wright Corporation, 30 Rockefeller Plaza, New York, N. Y., plans installation of electric power equipment in new aircraft-manufacturing plant at Lambert-St. Louis Airport, for production of airplanes for Government. Plant will comprise several large one and multi-story units. A steam power house will be built. Proposed to begin work soon. Entire project will cost about $8,000,000. Albert Kahn Associated Architects & Engineers, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Mont., Whitefish—City Council has engaged H. L. Gray, Stewart Building, Seattle, Wash., consulting engineer, to make surveys, estimates of cost and recommendations for a proposed municipal electric power plant. Project is expected to mature in 1941.

Neb., Kearney—State Board of Control, Lincoln, Neb., H. F. Peterson, secretary, has report from Fred R. Dickson, superintendent of State Industrial School, Kearney, recommending construction of new power plant at institution for electric power and central steam-heating service. Proposed to carry out project in 1941. Estimates of cost will be made.

N. C., Rocky Mount—Caromount Mills, Inc., plans installation of electric power equipment in new addition to plush mill for dyeing, finishing, etc. Entire project is reported to cost over $400,000.

Ohio, Dayton—Inland Mfg. Division, General Motors Corporation, 2727 Inland Avenue, manufacturer of plastic products, plans installation of electric power equipment in two-story addition to plant, 120x150 ft. Cost reported over $175,000. Proposed to begin work at early date. Argonaut Realty Division, General Motors Corporation, General Motors Research Building, Detroit, Mich., is engineer.

Ore., Dalles—Willamette Valley Lumber Co., Dalles, plans boiler plant in connection with rebuilding of lumber mill, recently destroyed by fire with total loss reported in excess of $400,000. Power equipment and mechanical-handling facilities will be installed in new mill units.

Pa., Sharon—Sharon Steel Co., Sharon, plans installation of electric power equipment in connection with expansion and improvements in mill. Also will install new electric furnace unit at plant at Lowellville, Ohio. Entire project is reported to cost about $1,000,000 and will be placed under way at early date.

S. D., Watertown—City Council will receive bids until Dec. 9 for extensions and improvements in municipal electric power plant, including installation of new steam turbine-generator unit of 3000-kw. capacity, condenser and auxiliary equipment. Ralph D. Thomas & Associates, Inc., 1200 Second Avenue South, Minneapolis, Minn., is consulting engineer.

Tenn., Godwin—Tennessee Valley Authority, Knoxville, Tenn., plans installation of electric power equipment in new phosphate rock plant in vicinity of Godwin, for raw material supply for commercial fertilizer works at Muscle Shoals, Ala. It will comprise several large units for crushing, classifying, drying, etc. All machinery will be electric-operated, with power furnished by TVA transmission system. Cost reported about $1,000,000. Department of Chemical Engineering is in charge.

Texas, Dallas—North American Aviation, Inc., Inglewood, Calif., plans power house, 59x119 ft., at new aircraft-manufacturing plant near Hensley air field. Will install electric power equipment for plant service. Project will include a series of six large buildings and is estimated to cost about $6,000,000. Lloyd Allen and Gordon Turnbull, Architects' and Builders' Building, Indianapolis, Ind., are architect and consulting engineer, respectively.

Wis., Rhinelander—Rhinelander Paper Co., Inc., has approved plans for new boiler house, 27x64 ft., at mill, with installation of boilers, pumps and auxiliary equipment. Also will install power equipment in new addition to mill, 100x450 ft., for expansion in beater department, machine room and finishing division for production of greaseproof, glassine and other processed paper stocks. Entire project will cost over $200,000.

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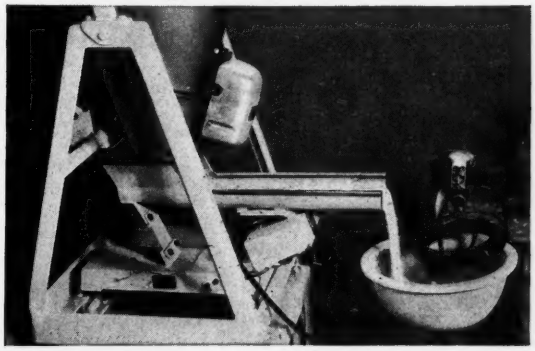

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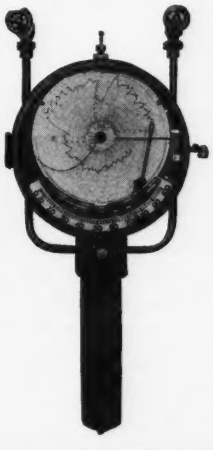

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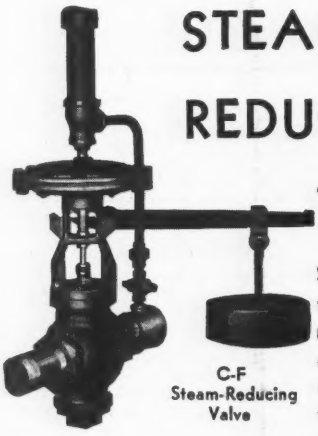

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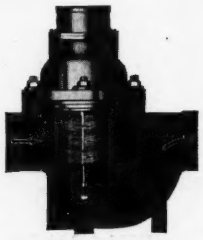

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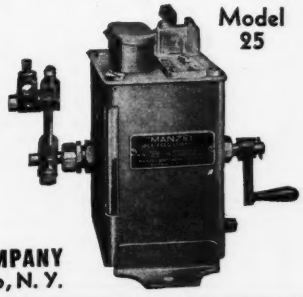

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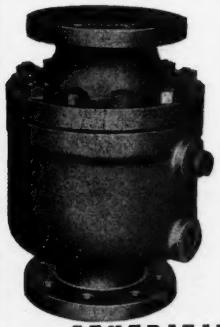

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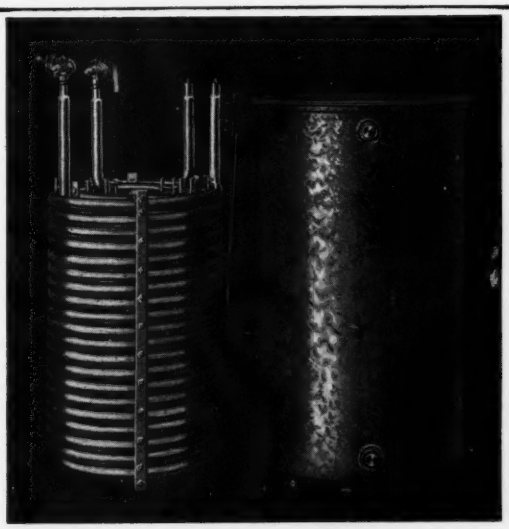

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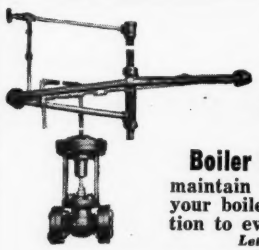

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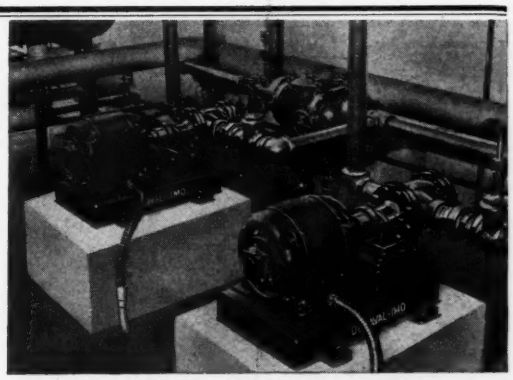

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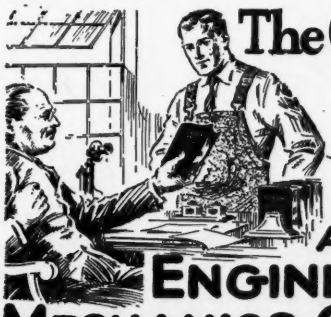
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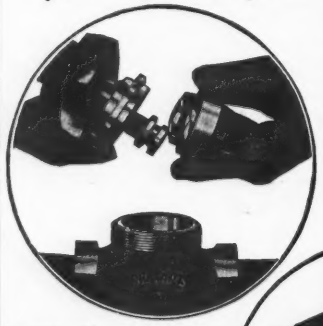

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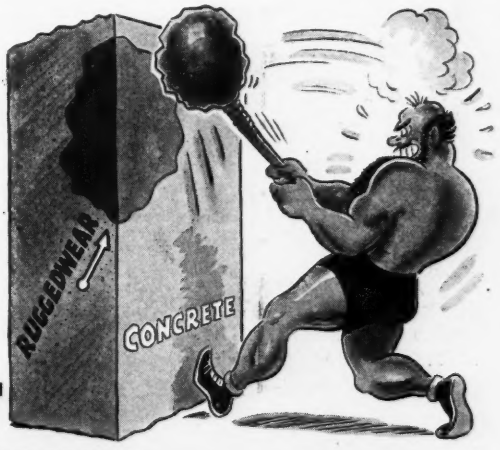

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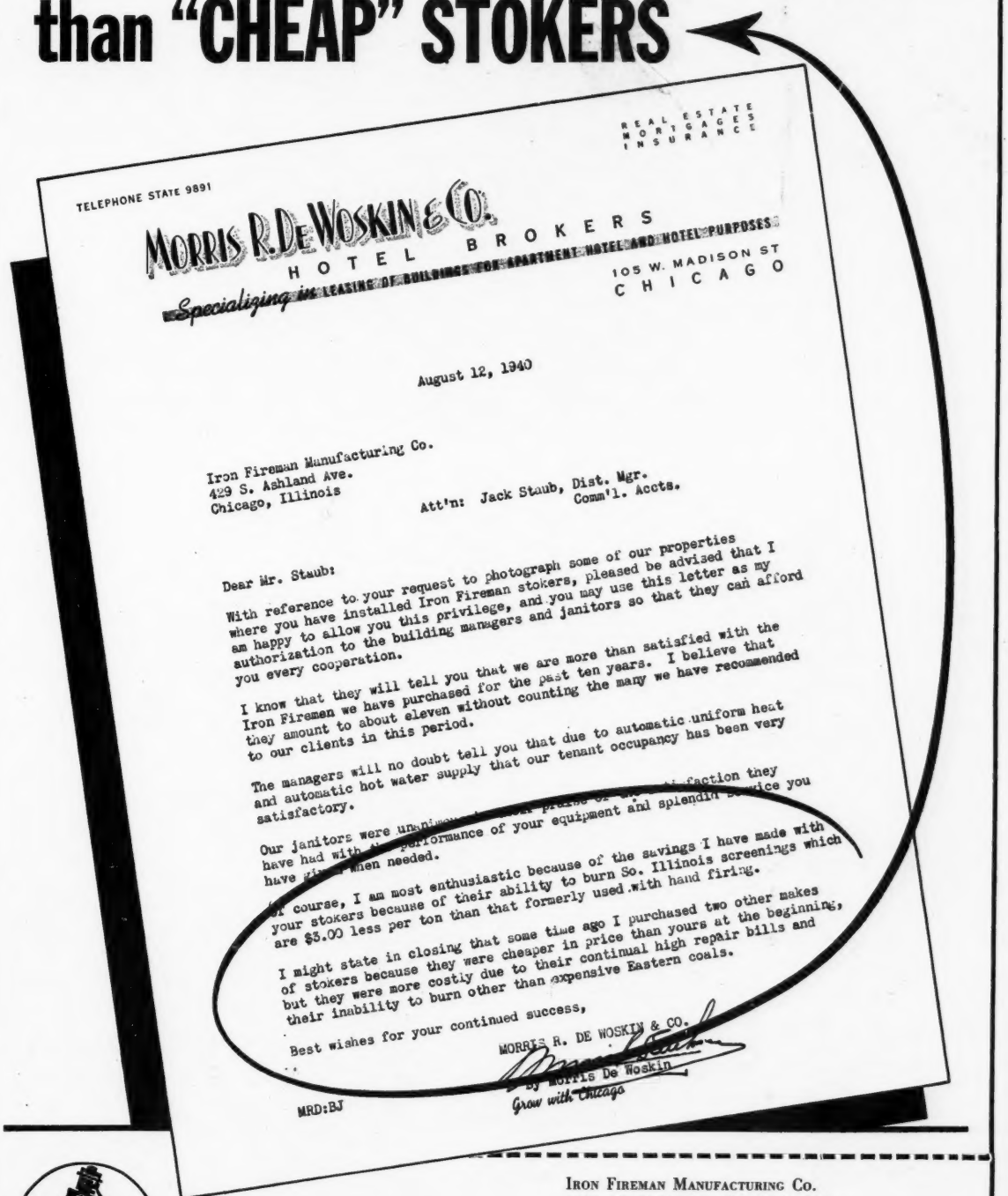

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CHICAGO

August 12, 1940

Iron Fireman Manufacturing Co.
429 S. Ashland Ave.
Chicago, Illinois

Att'n: Jack Staub, Dist. Mgr.
Comm'l. Accts.

Dear Mr. Staub:

With reference to your request to photograph some of our properties where you have installed Iron Fireman stokers, pleased be advised that I am happy to allow you this privilege, and you may use this letter as my authorization to the building managers and janitors so that they can afford you every cooperation.

I know that they will tell you that we are more than satisfied with the Iron Firemen we have purchased for the past ten years. I believe that they amount to about eleven without counting the many we have recommended to our clients in this period.

The managers will no doubt tell you that due to automatic uniform heat and automatic hot water supply that our tenant occupancy has been very satisfactory.

Our janitors were unanimous in their praise of the satisfaction they have had with the performance of your equipment and splendid service you have given when needed.

Of course, I am most enthusiastic because of the savings I have made with your stokers because of their ability to burn So. Illinois screenings which are $3.00 less per ton than that formerly used with hand firing.

I might state in closing that some time ago I purchased two other makes of stokers because they were cheaper in price than yours at the beginning, but they were more costly due to their continual high repair bills and their inability to burn other than expensive Eastern coals.

Best wishes for your continued success,

MORRIS R. DE WOSKIN & CO.

By Morris De Woskin

MRD:BJ

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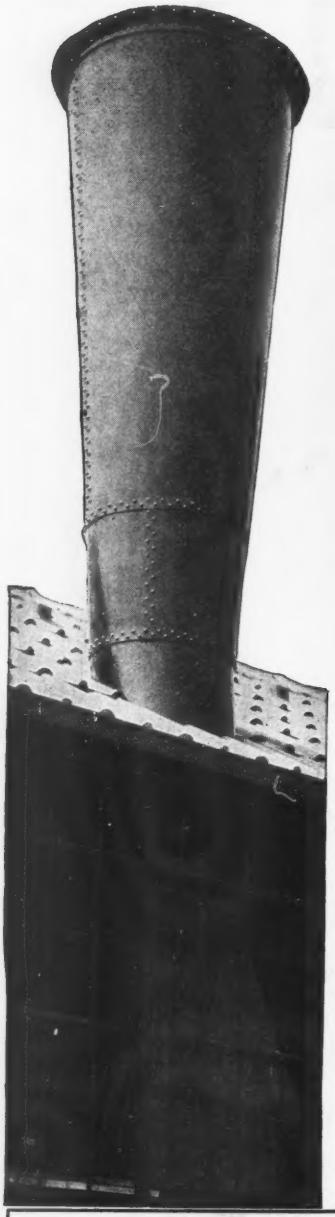

"Joe, you wouldn't buy the engine of your car from one manufacturer, the wheels from another and the body from still another, would you? Neither would I. And when I design for induced draft, I specify a Thermix Stack because the I.D. Fan, though it is important, isn't the whole story. The combined breeching, stack and fan, built as *one* apparatus, gives me unit responsibility, compact design, simplified engineering, and positive performance, with a lot less purchasing details.

"Another thing, I'd rather buy my Dust Collector from the same manufacturer that made my Stack and Fan. For this is all part of the same system for handling the gas after it leaves my boiler unit. If I wanted the very highest degree of collection, and had sufficient space, I'd buy a Thermix Controlled Multicyclone. But if my space were limited, or of some peculiar shape, I'd be almost certain to get in a Thermix Tubular Dust Collector; otherwise I'd install a Thermix Recirculator Stack, which combines the whole business in one machine.

"There's nothing like putting all the responsibility on *one* manufacturer's shoulders if you can, for then you'll come out on the long end nine times of ten. Buying such equipment piecemeal is antiquated and costly."

You can save a lot of time, trouble and money by purchasing your Stack and Dust Collector from Prat-Daniel. Our engineers are at all times ready to assist in solving your problems without cost or obligation to you.

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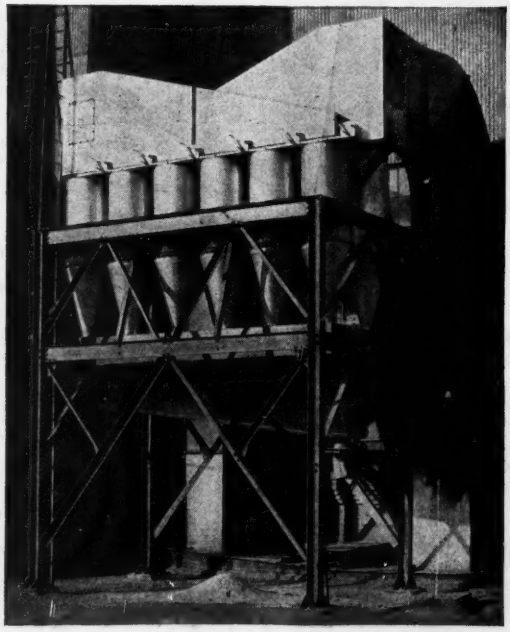

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